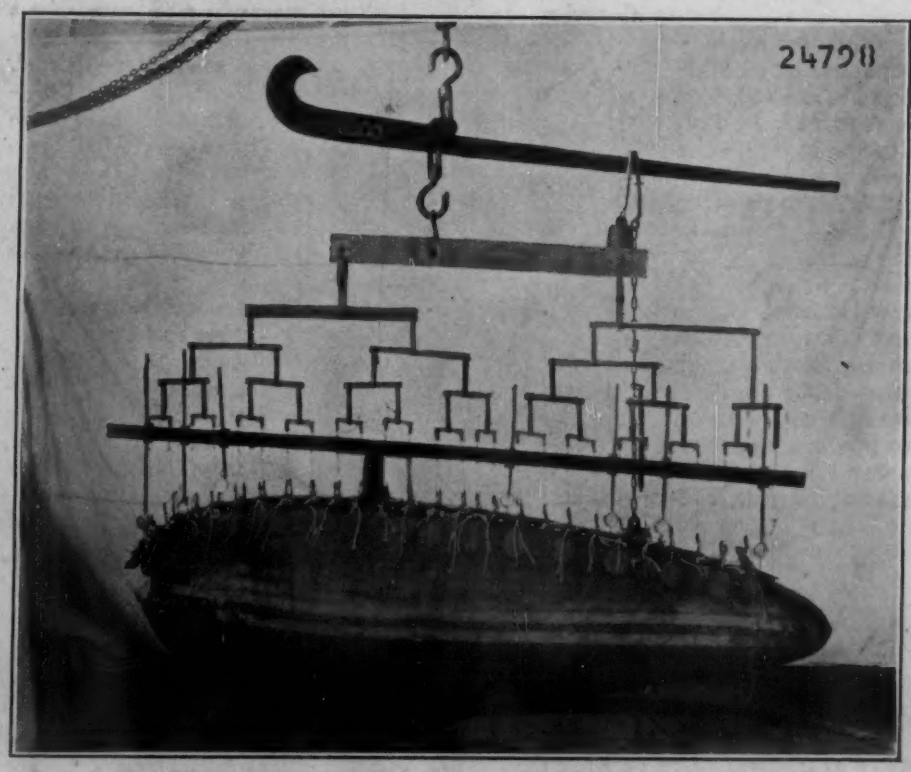
THE TECH ENGINEERING NEWS

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

VOL. VI, No. 3 OCTOBER, 1925



MODEL OF SEMI-RIGID AIRSHIP RS-1 SET UP FOR TESTING

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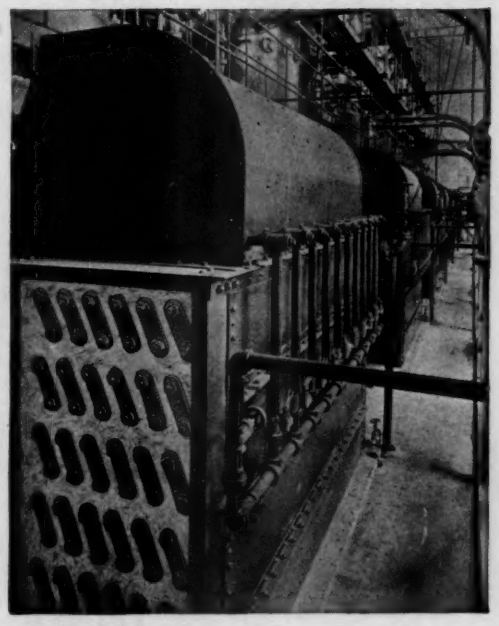
Replaces the inefficient part of the boiler



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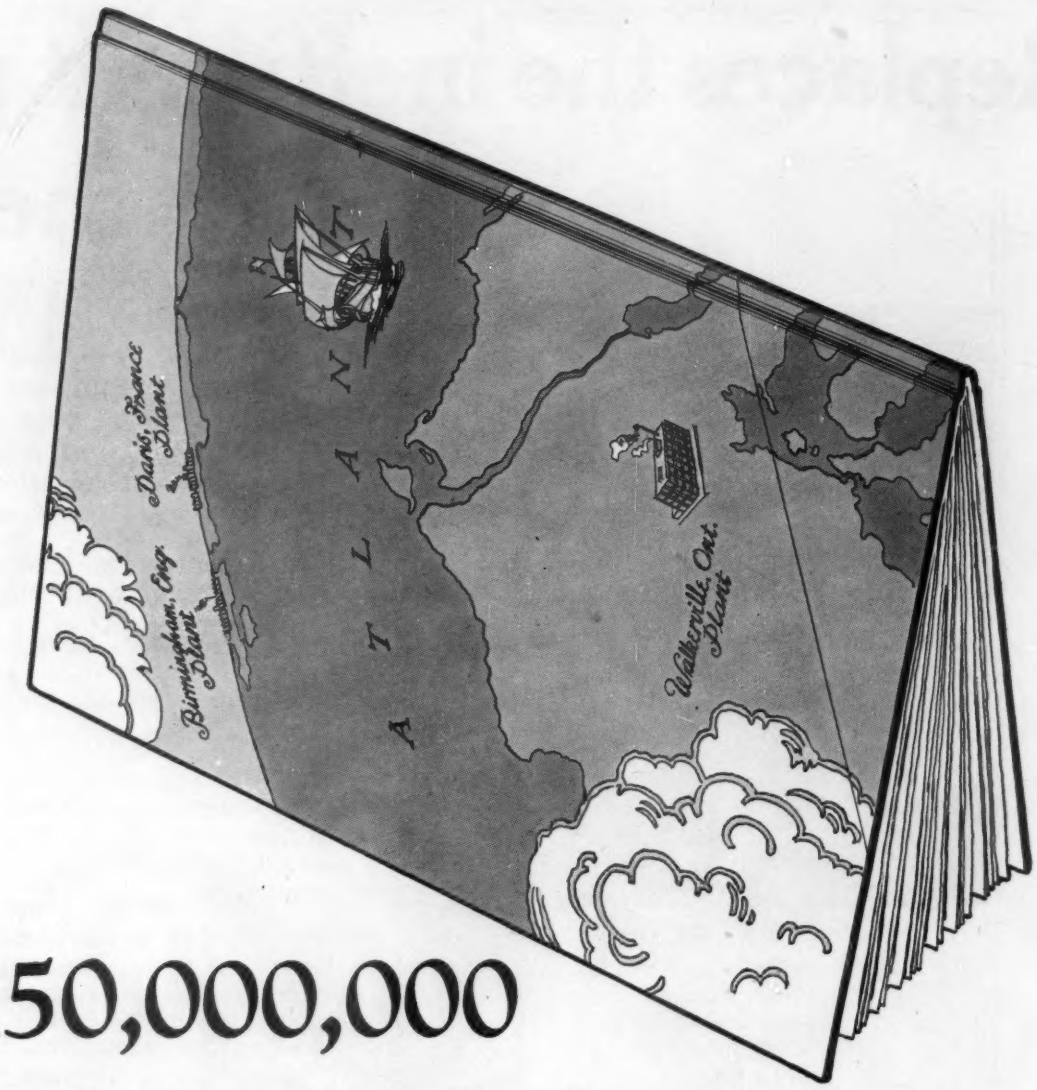

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THE TECH ENGINEERING NEWS

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THE TECH ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME VI — OCTOBER, 1925 — NUMBER 3

The Technical Graduate in Industry

Some suggestions as to what to do with a college education after it has been gotten

By E. B. ROBERTS

Westinghouse Electric and Manufacturing Co.

THE decision to go to college and pursue an engineering course is an exceedingly important one in the life of any young man making it. Recent investigations of engineering education show that it is generally contemplated throughout at least the latter years of high-school training. The writer, out of some years of intimate contact with a considerable number of college graduates, and with the records of interviews with over a thousand young Americans approaching the end of their senior year's work in our colleges before him, believes that more important is the decision as to *what to do with an engineering education* after it has been gotten. He has frequently told engineering classes before which he has been invited to talk that it is his opinion that that man in a particular class who stands middle or thereabouts in his group, but who carefully studies the field to be entered and elects work the requirements of which are consistent with his tastes and aptitudes, will go further in accomplishment and attain greater happiness than the honor man of the class who fails to make a decision as to type of work on the basis of a careful self-analysis.

It is highly important that those representatives of industry who annually visit colleges with a view to interesting seniors in this or that work have a clear conception of their opportunities and responsibilities. The same investigation referred to above shows that a surprisingly large number of graduates have secured their first jobs on the basis of these interviews and contacts. The men to whom this work is entrusted should be of broad gauge and with a conception of engineering and industry transcending the particular company with which they are associated. A great damage may be done in urging a certain action on the individual. Ofttimes a great service is to be done in urging an applicant toward another line of endeavor than that which the interviewer, perhaps, represents. Engineering deans, and other prominent educational executives with whom the writer has had contact, seem to feel that a great improvement is to be noted in respect to the way this work has developed during the last few years. It is not now at all uncommon to find industries sending out to the colleges to interview students high-calibered men—chief engineers, directors of engineering, sales managers, district superintendents, directors of personnel, educational managers, etc.

This article comes at a most opportune time, particularly for the men of the Freshman and Sophomore classes. The author enumerates in this article the fields in which the young engineer may find outlet for his abilities, and describes the personal characteristics necessary for each field of endeavor. The Freshmen, in particular, and the man who is still in the dark as to what courses of study he desires, should read this article and plan their courses for the coming year accordingly.

The author, upon mentioning the importance of a proper decision, says that the problem is "Not to go with this company or that company, this railroad or that one, this public utility or that utility, but how to get into that field where his usefulness will be the greatest, and where, by virtue of his own tastes, inherent or acquired, nature intended him to be."

Essential as a point of contact with the student is a spirit of helpfulness on the part of the interviewer. Notwithstanding all that has been said to the contrary, the attitude of the great majority of college seniors is good. A few exceptions coming before those of not too broad a contact have tended to condemn the whole group. The writer, during the spring, visited approximately forty American colleges, pretty well distributed geographically, and at each he was privileged to talk with not less than ninety per cent of the individual members of the senior classes in electrical and in mechanical engineering. The great majority of these young men recognize their need of experience, of contact with men, and the necessity of beginning their lifework at the bottom and building slowly from a solid foundation. He has not found money to be the uppermost thought in their minds. What they ask is an opportunity to come into an industry and learn the business; to get their feet on solid ground; to gain contacts with the various fields of activity embraced in the industry they enter before making a decision as to where they fit best and where they will permanently go. "Is there a fair chance to gain promotion as it is earned, and is there an opportunity to take on additional responsibilities as I become able to carry them?" is an almost universal inquiry. The representatives of industry must meet the sincerity of the engineering college senior with the tender of a real service of helpfulness.

What is the problem confronting the college man which makes his decision as to how to use his engineering education so important? Not to go with this company or that company, this railroad or that one, this public utility or that utility, but how to get into that field where his usefulness will be the greatest, and where, by virtue of his own tastes, inherent or acquired, nature intended him to be. It is no longer enough for a college man to say he is going to follow mechanical engineering, civil engineering, or electrical engineering. Every day industry is coming more and more to disregard this subject-matter classification of its engineering work and substitute for it an occupational or a functional classification.

(*Continued on page 117*)

Blood

A promising source of new foods and technical products

By S. C. Prescott, '94

In charge, Department of Biology and Public Health, Massachusetts Institute of Technology

TO meet the demands for our food supply, more than 85,000,000 animals are slaughtered each year in the United States. Of these, something over 15,000,000 are cattle and calves, over 13,000,000 are sheep and lambs, while swine to the number of 57,000,000 are killed.

In connection with the slaughter of this large number of animals for food purposes, there is a large amount of blood which must, in the process of slaughtering, be drawn from these animals. This blood, from healthy animals killed under Government inspection, has had a limited use. Previously, its ultimate destination has been largely as an ingredient of tankage worked over into fertilizer, but some has been defibrinated and used in the leather industry, or in the manufacture of waterproof glues. A limited quantity has been taken for use in the preparation of blood sausage, and a small portion has been imperfectly separated into so-called hæmoglobin, used for pharmaceutical purposes, as an ingredient of iron-containing tonics, and for certain medicinal products, while the other fraction has been sold under the name of blood albumin. The amount so used has been but a small fraction of the total quantity.

Blood albumin has had a technical use chiefly in the finishing of leather. Other technical applications of blood albumin have been in printing of cotton cloth, as a clarifying agent, in the preparation of certain bacteriological culture media, and as a mordant in painting.

There have been from time to time attempts to use blood or blood products in food, most of this work having been done in Germany. As an ingredient for cattle food, or for use in sauces and soups, and in sausage, various products have been offered for sale in European countries. In no instance has the use been widespread.

Numerous attempts have been made to seek a wider utilization of this substance, so rich in the materials needed for the upbuilding of the animal organism. An American firm has offered for sale, with some degree of success, a chocolate-covered candy containing hæmoglobin in the filler, with the idea that iron in organic form is offered at the same time that the palatable sweet is taken. These various attempts have been made because of the realization that blood contains substances which should have nutritional value, although blood is largely water. Physiological chemistry reveals that in this watery substrate are dissolved inorganic salts, colored substances, and proteins. Suspended in the fluid medium are red and white corpuscles, each containing proteins, phospholipins, and other organic substances. The liquid portion of whole blood is known to the physiologist as plasma. From 60 to 70 per cent by volume of mammalian blood is plasma. The corpuscles make up the remainder. Dissolved in the plasma in life is a substance usually referred to as fibrinogen, which upon contact of the blood with any surface other than the unbroken lining of the blood vessel is ordinarily precipitated out in threads of so-called fibrin which help to form a blood clot. This clot renders a mass of blood drawn from a slaughtered animal a semi-solid, jelly-like mass in a short time unless steps are taken to counteract the phenomenon. From such a clot, in time, there will exude a straw-colored liquid called serum, the difference between plasma and serum being largely the presence of soluble fibrinogen in the former and the absence of fibrin in the latter.

The chief recoverable proteins of blood are contained in the red corpuscles and in the serum. The protein of the red corpuscles is a conjugated chromoprotein, hæmoglobin. From the serum there can be recovered by suitable processes so-called serum albumin, which, as a matter of fact, is a mixture of serum albumin and serum globulin. The amino acid content of these serum proteins suggests that they would be useful for food purposes.

A few years ago studies were begun on the possible utilization of blood as a commercial source of food materials, and this work has been prosecuted vigorously in the Biological Department of the Institute by Professor Bunker, who has charge of the work in biochemistry. It had been found that at least four of the essential amino acids which occur in protein substances cannot be synthesized in the animal body. These are cystine, lysine, tryptophane, and tyrosine. The acids mentioned must, therefore, be included in our diet if we are to be properly nourished. Without listing the complete analysis of serum protein, in so far as it is known, it may be pointed out that three of these important amino acids, tryptophane, cystine, and tyrosine, are all present in appreciable amounts.

The ultimate test of the availability of these amino acids must be by animal feeding experiments. Tests in which coagulated dried-blood albumin was

BEATING UP BLOOD SERUM IN RESEARCH LABORATORY

The white material in the bowl is beaten up blood serum, and resembles in appearance the beaten white of an egg. The large erlenmeyer flask on the laboratory desk contains the blood serum.

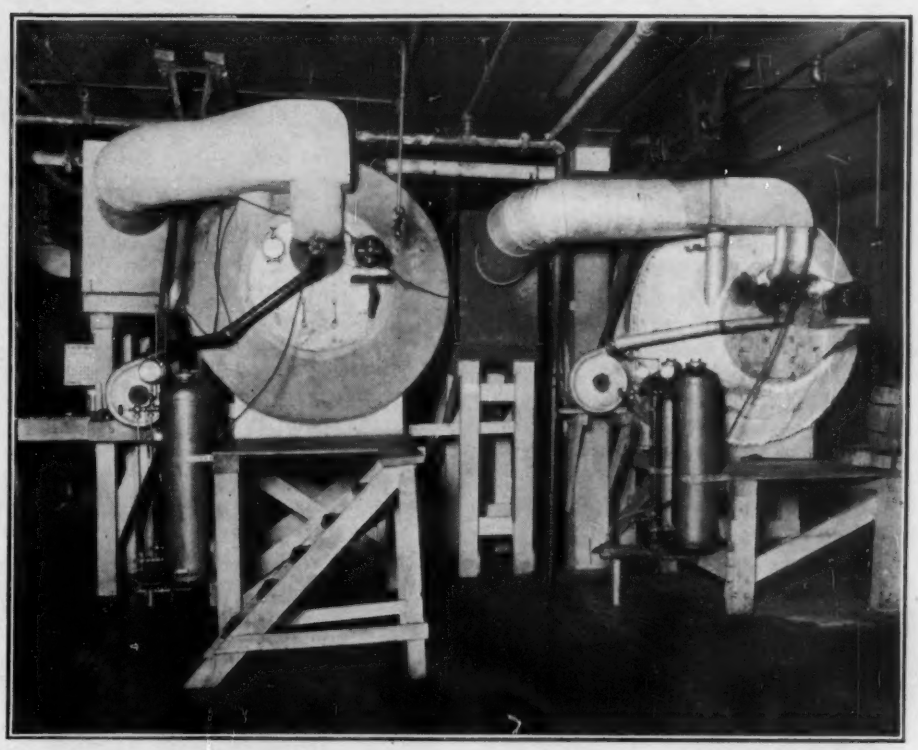
employed as a sole source of protein in the basal diet of white rats have been made by Dr. Bunker with interesting results. The rats thrived on this diet and their weight curves were eminently satisfactory. On raw albumin these animals sickened and did not gain, but coagulated or cooked albumin gave excellent results, and thus appears to be digestible protein. Experiments *in vitro* with pepsin and pancreatin from commercial sources also indicate that cooked albumin is digestible.

By the use of a specially designed centrifuge, the blood from inspected animals is separated into a straw-colored plasma and a heavy red liquor containing all the hæmoglobin in corpuscular form, and this process is now a part of the procedure of the American Protein Corporation in its present production of blood proteins. The first problem to be met in production was the securing of uncoagulated blood from animals that had been approved by inspectors of the Bureau of Animal Industry. A plant was installed in one of the packing-houses where a sufficient volume of blood would be assured, only the blood from beef animals being taken. Animals killed in the regular routine, with the exception of kosherd animals, are used, and the first step in the process is to secure the blood as aseptically as practical without interfering with regular slaughter-house procedure. This is accomplished by the use of individual containers for receiving the blood from each animal separately, and by substituting for the regular knife used for "sticking" a special improved knife having a hollow handle and a suitable guard so that blood, gushing from the wound, does not come in contact with the hide of the animal. After the animal has been "knocked," an incision is made with the knife in the same manner as commonly practised with the ordinary butcher's knife, and the blood allowed to flow into a prepared container.

The containers for receiving the blood are thoroughly washed and steamed, and in each is placed a measured amount of an anti-coagulant before sending it to the killing-floor. Each container is also numbered, and when an animal of corresponding number has been "passed" by the inspector, that can of blood is also "passed" as suitable for food purposes, while the blood from any condemned animals is discarded.

The blood, with its added anti-coagulant, remains liquid and does not clot. It is immediately passed through a continuous centrifuge fitted with a specially designed bowl which separates the red corpuscles from the straw-colored plasma. This plasma contains fibrinogen, which is later removed.

From the centrifugal separators the plasma is pumped to cooled storage tanks where the next step, defibrination, is carried out. The red material is sent to a special spray drier to be described later.



APPARATUS FOR DRYING THE BLOOD SERUM

The spray driers are so constructed to prevent coagulation of the blood serum while drying. A spray of cold air and a revolving core in the drier accomplish this.

Defibrination is a process of precipitating the fibrin and subsequently removing it mechanically. In the normal clotting of blood there must be present certain amounts of calcium salts in solution. These calcium salts are normally present in the blood of warm-blooded animals. The addition of anti-coagulant is for the purpose of preventing the chemical interaction of the calcium ions which is necessary in the precipitation action of clot formation. To induce this reaction in the plasma, therefore, an excess of calcium ions is later added, and at once the normal clotting or precipitation of fibrin commences. By mechanical agitation and the use of suitable heat this defibrination is rendered complete.

The defibrinated plasma is now nearly serum, in the strict sense of that term. It contains, however, some fibrinogen which, upon standing, would "snow down" as minute flecks of fibrin, and it contains certain lipin-like bodies which, if not removed, would render the finished product liable to develop rancidity.

Following defibrination and the mechanical removal of the major fibrin mass, the liquid is treated further to extract these lipin-like bodies, and practically all of the residual fibrinogen. The serum is then passed through a clarifier.

As a result of these processes a straw-colored serum is now available. This serum is concentrated under vacuum, a process which required a specially designed tubular evaporator because of the well-known tendency of blood serum to foam when agitated.

The serum, concentrated to 15 Beaumé, may be shipped as such with a suitable preservative for technical purposes only, or it may be sent direct to the driers to be rendered into a soluble powder for food purposes.

The drier used for this purpose, as also the twin drier used for drying the red "hæmoglobin," is of a novel type in which a small jet of liquid to be dried impinges upon the inner surface of a small cylindrical shell revolving at high speed, where it comes in contact with a blast of hot, dry air which removes from the sprayed liquid its water content, reducing it to a fine powder.

The dried serum protein has a moisture content of about 6 per cent, is of a yellowish color, nearly or quite lacking in odor, and is soluble in water. Throughout the process, precautions are taken to prevent bacterial contamination, and at no stage is it handled. Prepared as it is from approved, inspected food animals, the dried serum is a product suitable in its sanitary aspects for human consumption. From a consideration of its chemical composition its food value is assured, and by actual use its place has been established in the realm of

(*Continued on page 120*)

Water Models for Aeronautical Tests

A description of the tests made on a water model of the semi-rigid airship RS-1 at the Massachusetts Institute of Technology

By WILLIAM HOVGAARD
Professor of Naval Design and Construction, Massachusetts Institute of Technology

THE term "water model," as applied to airships, is somewhat misleading, as it does not mean a model run in water, as for an ordinary ship, but a model filled with water. The term is used in contradistinction to a true airship model which would be filled with gas. Water models were originally introduced to investigate the strength of non-rigid airships, and on account of the simple construction of such craft, their application was easy and gave very satisfactory results. In so far as known, water models had not been used for semi-rigid airships before it was attempted in the case of the U. S. Army Airship RS-1.

The mathematical reasoning which led to the use of water instead of gas for such models will not here be given; it is enough to point out that when the gas bag of an airship is turned upside down and filled with water, the internal pressures increase in a linear ratio from the upper to the lower part of the model, quite corresponding to the increase in gas pressures from the bottom to the top of an actual airship. The weight of the water takes the place of the buoyancy of the gas. The fabric used in the model is identical with that of the envelope of the ship, and it is simply a matter of scale to obtain the same tensional stresses in the model as in the ship. When helium is used, the proper linear ratio between model and ship is 3:100, and this was the ratio used in the model of the RS-1.

The semi-rigid airship has been developed chiefly in Italy, and the first ship of this type acquired by the United States, the ill-fated *Roma*, was built in Italy. Shortly after, a still larger ship of the same type was ordered by the Air Service of the United States Army from the Goodyear Tire and Rubber Company at Akron, and this ship, the RS-1, is now just completed. It is the largest semi-rigid ever built, and has a volume of 750,000 cubic feet, a length of 282 feet, and a maximum diameter of about 70 feet. It is driven by four motors, capable of developing an aggregate of 1200 h. p., giving a speed of 70 m. p. h.

The loss of the *Roma* naturally caused considerable concern as to the design of the new ship, which was in several essentials of similar type, and a most careful study was made of its strength and other features.

Figure 1 shows the general design of the RS-1, which differs radically from a non-rigid in that a keel of duralumin is built into the envelope, and forms, as it were, the backbone of the structure, running the full length on the under side of the bag. The keel is a truss girder of equilateral triangular section with horizontal base continuous with the contour of the envelope and with its apex pointing upwards inside the bag. It is built of thirty-one sections, each one consisting of three longitudinal columns connected with ball and socket joints to transverse triangular frames. The panels so formed are prevented from distortion by diagonal wires. The keel curves upwards towards the nose and tail, and is connected with the top of the envelope by internal suspension wires, giving the section of the envelope a cardioidal shape. The duralumin work as well as the bag and ballonets, were all made by the Goodyear Company, and are of unsurpassed excellence of material and workmanship.

In considering the problem of general longitudinal strength, several important questions arose about which it was impossible to form a definite opinion on the basis of theoretical considerations alone, and as no other ships were available at that time for full-scale tests, model experiments offered the only possibility of obtaining the desired information.

It seemed very doubtful, however, whether it would be possible to obtain results with a model of such a compound structure, built up of two widely different materials, but finally the Air Service decided to have a model made and tested independently.

The principal object of the model tests was to study the interaction between keel and envelope when subject to longitudinal bending. Some held that the envelope could not be relied upon to render assistance to the keel; and, in fact, in the absence of reliable data, the keel was designed to carry the entire load. Others were of the opinion that the keel would always receive considerable assistance from the envelope; it was argued that since non-rigids possess sufficient strength, depending entirely upon the envelope, while rigid airships depend entirely upon a rigid framework, the semi-rigid, being intermediate between the two, may be expected to derive its strength from both the envelope and the keel.

It was desired also to study the so-called "breathing" deflections and stresses called forth in a semi-rigid by variations in gas pressures, such as may be caused, for instance, by rapid changes in altitude. When the pressure is altered, the bag suffers deformations, which, especially in a ship of cardioidal section, will produce stresses in the keel. This action was first pointed out, and its magnitude predicted on theoretical grounds, by Mr. W. W. Pagon, a member of the Special Committee on the Design of RS-1, and was found actually to exist, as proved by model experiments as well

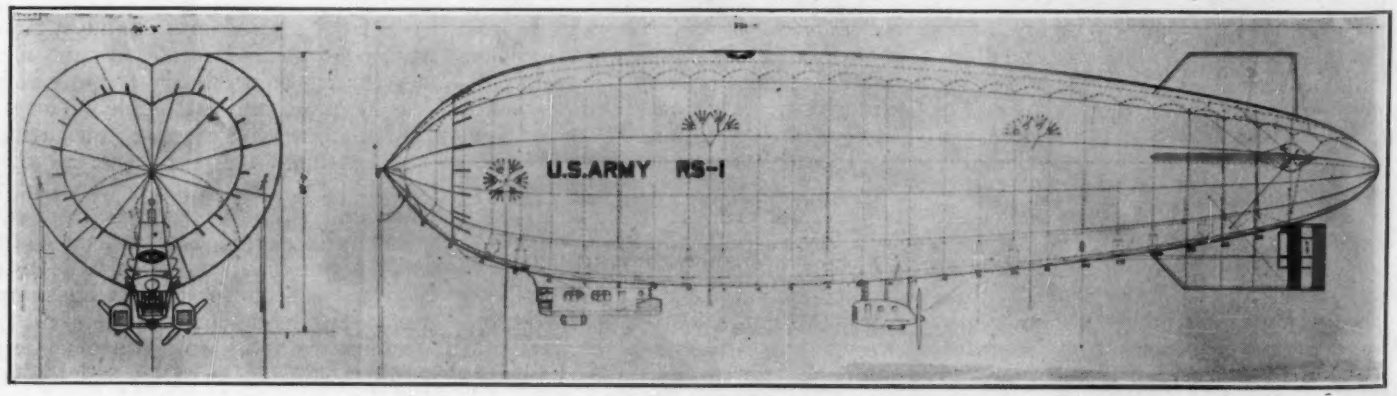


FIG. 1. SECTIONAL VIEW OF THE SEMI-RIGID AIRSHIP RS-1

as by full-scale tests. It does not exist in rigid airships, and in non-rigids, where no keel is found, it simply causes deformations of the bag.

In order to differentiate the various actions it was necessary in the model experiments to proceed analytically and to adopt simple standard conditions of fixation and loading. The interaction between keel and envelope had to be studied by measuring the deflections under a given load of keel and envelope, each separately, as well as of the complete model—keel and envelope combined. The model was to be so constructed that under similar loading conditions the deflections of ship and model should be in the same ratio as the linear dimensions, but in order to attain this object both in shearing and bending the corresponding elastic constants of the model had to bear certain definite ratios to those of the ship.

While, as usual in water models, the envelope was made of the identical material as in the ship, the problem of constructing a keel with the desired elastic properties was not so simple. To build the keel to scale of duralumin was out of the question, and it was decided to make it of wood, which promised to furnish the simplest and least expensive solution. After making a series of preliminary tests on straight pieces in order to determine the fundamental elastic properties of the wood, the keel was made of ten thin boards of mahogany. The boards were glued together, bent to the exact shape of the keel, and finished with the correct sections to scale. This difficult work was carried out with great skill by the model-maker of the Massachusetts Institute of Technology, Mr. George O'Hara, to a set of lines prepared by Professor H. H. W. Keith. The metal fittings were made by Mr. Carl Selig of the Department of Physics. When the keel was finished, it deviated by less than .2 in. from its correct form at the ends, and it never changed its shape appreciably.

The keel as first made was of solid section, and there remained the problem of so reducing its strength and stiffness as to endow it with the desired moduli of shear and flexure. This was accomplished by a tentative process in which the stiffness was gradually reduced by removal of material until the deflections under definite conditions of loading were similar to those of the actual keel under corresponding load. For this purpose it was necessary first to calculate what the deflections of the ship's keel would be, and to this end a generalized method was used in which the keel was regarded as a unit curved girder of varying section and moment of inertia. The keel was assumed to be clamped down firmly at its lowest point where it runs horizontally, and loaded at both ends with a vertical or horizontal load so adjusted as to produce equal and opposite bending moments at the fixed section. The case of a pure couple applied at each end was also considered. Formulas for determining the deflections were developed and the deflections calculated with assumed values of the physical constants for duralumin and steel wire. The total deflections in each case were found as the sum of the deflections due to bending, shearing, and also, in case of transverse end load, due to torsion. The application of pure couples at the ends furnished deflections for pure bending, while the end loads furnished deflections due to combined shear and bending, and it thus became possible to ascertain separately the respective moduli.

The tests were made in the Testing Materials Laboratory of the Institute, in which work Mr. R. G. Adams of the Department of Mechanical Engineering rendered valuable assistance. Fig. 2 shows the general set-up and the mode in which the deflections were measured. The preliminary tests and the preparation and adjustment of the keel extended over several months. As finally adjusted the model keel showed deflections which corresponded very closely with the calculated values.

When the keel was ready it was shipped to McCook Field, where also the envelope was delivered by the Goodyear Company, and in November, 1924, a series of tests were made with the complete model as well as with the envelope alone, applying the same loading as in case of the bare keel.

During these tests which took place at Wilbur Wright Field, the model was suspended upside down in a wooden frame. The downward pull, which in an actual ship is produced by the cars with machinery, the gasoline, water-ballast, bombs, etc., was represented by the upward pull of a number of cords which at first were taken over pulleys and carried counterweights so adjusted as to produce exactly the equivalent of the weights in the ship. The tests were made with the assistance of Lieutenant R. E. Robillard of the Air Service, a former Tech graduate, who afterwards made a second series of tests in order to obtain a check on the first experiments. In the second series Lieutenant Robillard devised a new and ingenious method of counter-balancing by which the counterweights were replaced by suspension from a scale-beam through a system of levers so adjusted that the correct system of upward forces was obtained. This arrangement is shown in Fig. 3.

The tests comprised vertical and transverse end load, torsion, and "breathing," in all of which the deflections were measured by Ames' dials. In connection with the breathing tests

(*Continued on page 122*)

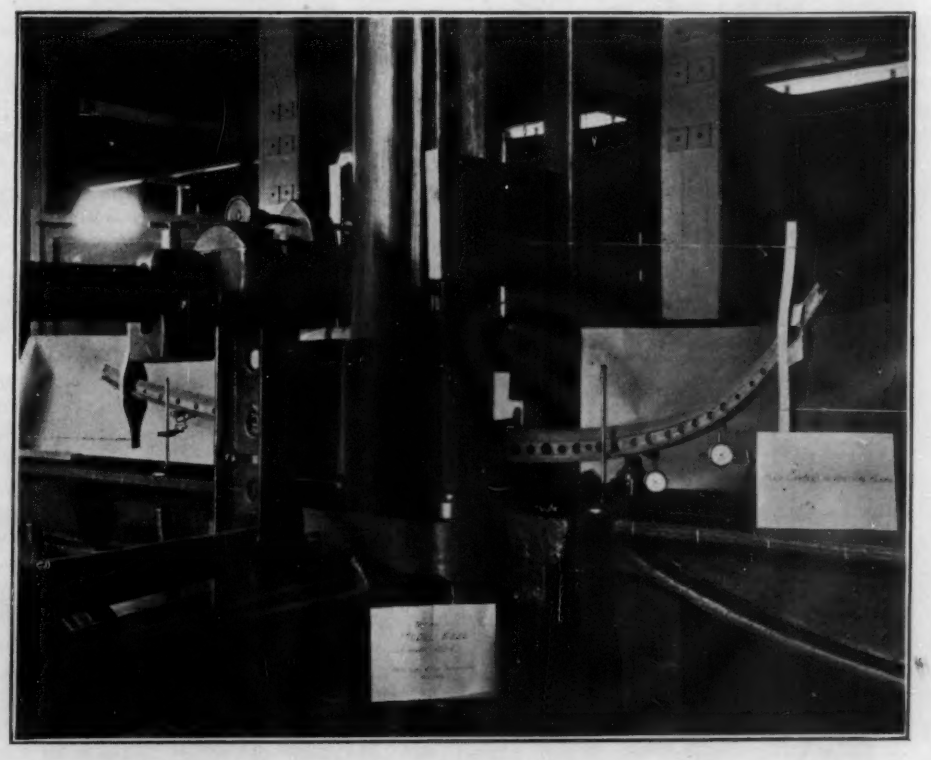


FIG. 2. GENERAL SET-UP FOR PRELIMINARY KEEL TESTS

The tests were made in the Testing Materials Laboratory of the Massachusetts Institute of Technology.

Non-Corrosive Steels

An account of the characteristics and production of stainless and rustless steels, including a discussion of corrosion

By F. R. PALMER
Carpenter Steel Co., Reading, Pa.

ALTHOUGH stainless steel, as a commercial reality, dates back only to the middle of the last decade, the stainless idea is as old as the history of the human race. The noble and semi-precious metals have been hoarded and cherished by mankind since time immemorial, largely because of their stability and non-perishable nature. Scientists and engineers have made shift for centuries with certain non-ferrous alloys (notwithstanding their low physical properties) on account of their ability to resist corrosion, and it is small wonder that the advent of a commercially practical stainless steel was so spontaneously welcomed. The effect of large percentages of chromium in conferring non-corrosive properties on steel was pointed out by several early investigators, but no commercial use was made of this idea until Harry Brearley, in England, and Ellwood Haynes, in America, almost simultaneously took out patents on the non-corrosive properties of high chromium steels. The development of stainless steels was retarded considerably by the World War, although hundreds of tons of these alloys were used during the War for exhaust valves in air-plane engines. Since the War the applications of stainless steel have multiplied enormously, and at the same time new types of rust-proof and stainless steels have been developed to solve the new problems that have arisen.

In order to understand the whys and wherefores of the various types of non-corrosive steel, it is important to bear in mind some of the fundamental principles of corrosion. This is very simply illustrated by an experiment first described by Mr. Brearley. If a small piece of pure electrolytic iron is placed in a test tube, and the tube is filled with water which has been boiled to remove the air, and then tightly corked, there will be no apparent change in the contents of the tube. The iron will remain bright and the water will remain colorless and clear. If the cork is removed after some days, so that the water will be in contact with the air, a reddish brown cloudiness will develop in the water due to the formation of hydrated oxides of iron. The experiment may be carried a step further. The pure iron is placed in the tube as before, but the tube is only half filled with boiled water. A roll of filter paper is shoved half-way down the tube, and the tube is then filled with more boiled water, but is not corked. The iron begins to dissolve in the water in the lower half of the tube and air begins to dissolve at the surface. Convection is prevented by the roll of filter paper, but in due time a ring of the reddish precipitate, or rust, will appear at about the middle of the roll of filter paper. These experiments prove that pure iron is soluble in pure water, but that rust, as such, appears only in the presence of air or oxygen. Mr. Brearley demonstrates in this way that the first step in developing a rust-proof steel is to add some element to the iron in a sufficient proportion to render it insoluble in water.

The element used by both Brearley and Haynes to inhibit the solution of iron in water is chromium, and it has been established that this element, when present to the extent of 7 per cent or 8 per cent, will cause pure iron to become insoluble in water.

The second important phase of corrosion and rust is the electrolytic action which develops as soon as carbon is added to the pure iron. Carbon does not exist in steel as such, but in the form of iron carbide (Fe_3C). This is a flinty, hard, metallic compound which exists in annealed steel in the form of globules or small plates. Iron carbide is electro-negative with respect to iron, so that when annealed steel is moistened by an electrolyte, electrolytic action is set up between the carbides and the iron matrix which results in the destruction or solution of the more electro-positive iron.

When small quantities of chromium are added to steel, at least a part of this chromium does not dissolve in the iron matrix, but is taken up by the carbide, to form double carbides of iron and chromium. The most stable carbide of chromium is Cr_4C, and the double carbides appear to be definite compounds of this carbide with Fe_3C. As the chromium content is increased the tendency is to reduce the amount of iron carbide and increase the amount of chromium carbide until, with very high percentages of chromium and relatively small amounts of carbon, the iron carbide is apparently entirely displaced by chromium carbide and the steel at this point has a matrix which is a solid solution of iron and chromium (with small percentages of manganese, silicon, etc.), in which is imbedded the carbide, Cr_4C. It will be seen from this formula that each part of carbon takes up over seventeen times its own weight of chromium. Since approximately 8 per cent of chromium is required in the matrix to render the iron insoluble in

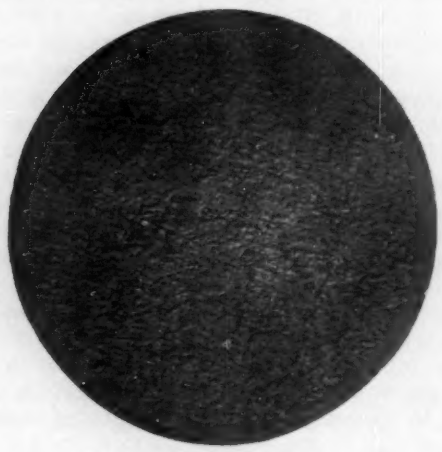


PLATE I
Stainless cutlery steel in the annealed condition.

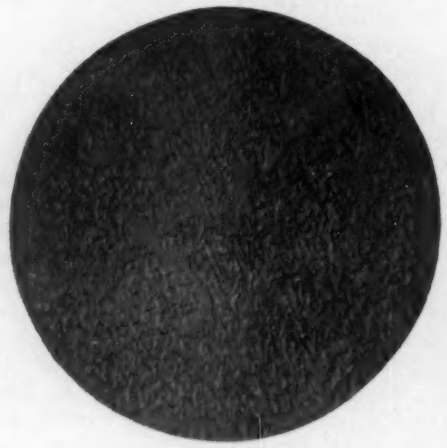


PLATE II
Stainless steel quenched from about 1575° F. Only a small percentage of the surface is hardened.

PLATE III
Hardening temperature raised to 1650° F., causing an increase in the percentage of carbides dissolved.

water, the total chromium content in steel must be considerably more than this in order to saturate the carbides. We will leave this idea for a minute to consider another effect of chromium.

When a straight carbon tool steel is hardened by quenching from just above its critical transformation point, the iron is capable of dissolving about .85 per cent in the form of Fe_3C. If there is more carbide than this, it will not dissolve unless the hardening temperature is raised, and if there is less carbide than this, the iron is not saturated. A simple carbon steel containing .85 per cent carbon is said to be of eutectoid composition because this is the carbon content of pearlite which is a eutectic of iron and iron carbide. The important point to remember is that the eutectic carbide is all that can be dissolved at the minimum hardening temperature. When chromium is added to carbon tool steel, the position of the eutectoid is progressively lowered; if 1.00 per cent of chromium is added, the eutectoid is lowered to about .80 per cent carbon; 5 per cent of chromium reduces it to about .65 per cent carbon, 10 per cent brings the eutectoid to about .45 per cent, and 13 per cent to .35 per cent. It will thus be seen that a non-corrosive steel containing large percentages of chromium will contain much less carbon than a simple carbon steel in order to maintain a structural similarity.

Going back to our electrolytic theory, we now have a steel to which sufficient chromium had been added so that the matrix is insoluble in water. The presence of carbon, however, introduces carbides, and electrolytic corrosion will progress rapidly in the presence of an electrolyte. In order to eliminate this electrolytic action, we must either eliminate the carbide or dissolve it in the matrix so that the steel will be of uniform consistency. We cannot entirely eliminate the carbon, on account of manufacturing difficulties, and also we need it in order to get high physical properties and hardness. We therefore harden the steel in order to make it stainless. If we are going to harden the steel at the minimum hardening temperature, and expect to get all of the carbides in solution, the steel must not contain more than the eutectoid percentage of carbon. This fixes pretty definitely the ideal composition for a stainless steel which is to possess maximum hardness along with maximum stain-resisting properties. Such a steel will contain about .35 per cent carbon and about 13.00 per cent chromium. This percentage of carbon takes up 17 times its weight of chromium, or about 6 per cent, and this leaves 7 per cent for the matrix.

A careful consideration of the above explanation will answer most of the questions which are asked about the "why and wherefore" of the analysis of stainless steel as patented by Mr. Brearley. It would appear at first glance that the addition of more carbon would cause the steel to harden better, but additional carbon would be useless unless the hardening temperature was raised in order to dissolve it, and this is undesirable for several reasons. Stainless steel of the ideal composition must be hardened at about 1850° F., and it is very undesirable to heat finished parts much higher than this in order to get them hard. Unless the high carbon stainless steels are hardened at a high enough temperature to dissolve all the carbide, they have inferior non-corrosive properties due to the electrolytic action of the undissolved carbides. The standard stainless steel which is marketed in this country, and appeared under the name of "Stainless Steel," contains about .35 per cent carbon and 13.00 per cent chromium with small quantities of silicon and manganese (usually less than .50 per cent) and a minimum of impurities such as phosphorus and sulphur. For convenience we will refer to this as "Stainless Cutlery Steel," since it was originally used chiefly for that purpose. The other types of non-corrosive steel have grown out of this type as a base.

Stainless cutlery steel naturally exhibits some non-corrosive properties in the annealed condition, but it is only by proper hardening that its maximum stainless properties are developed. Since hardening is such an important factor in the use of this steel, it will be well to discuss some of the peculiarities of the hardening operation.

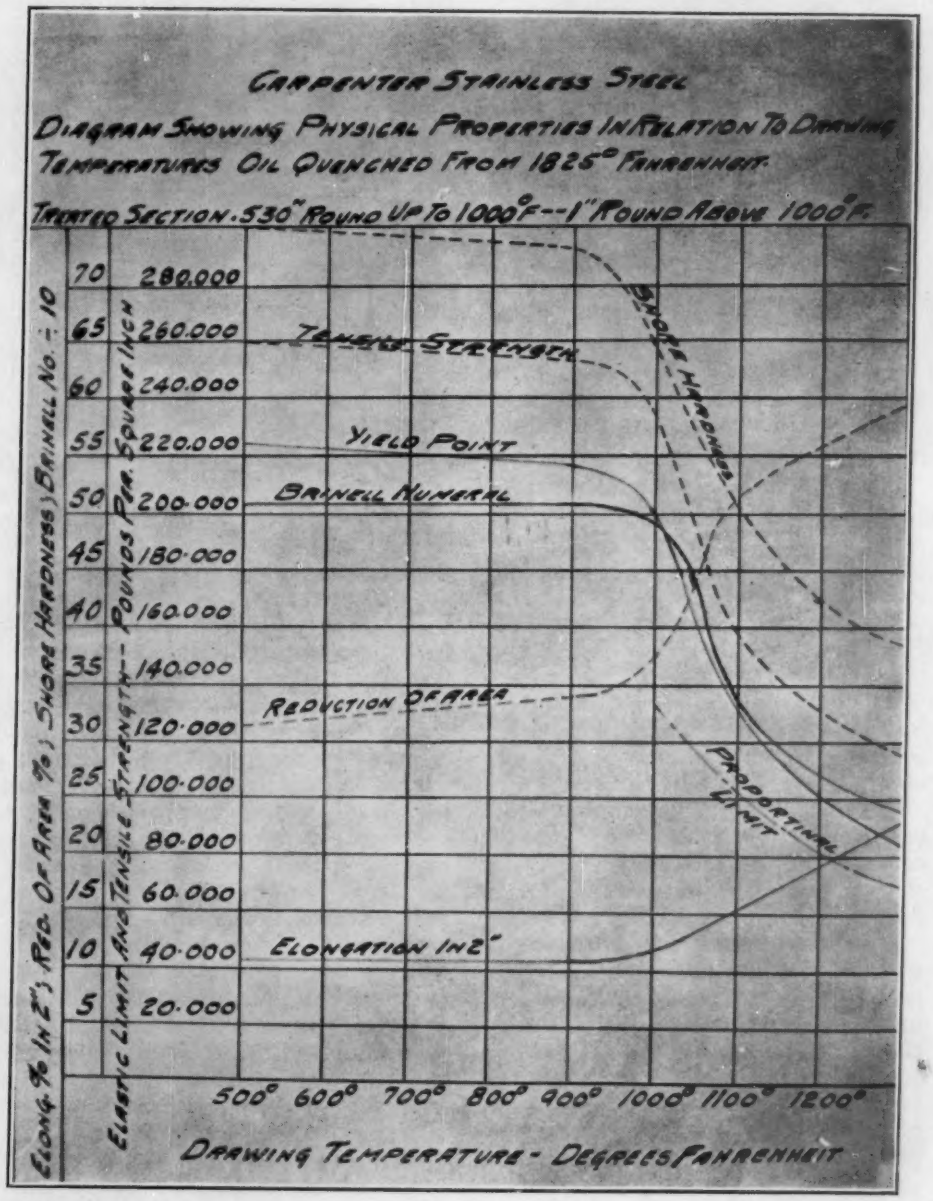


PLATE VI

The thermal critical point of stainless cutlery steel is about 1540° F., so that theoretically stainless steel should become thoroughly hard when quenched from slightly above this temperature. As a matter of fact, solution of the carbides does commence at the critical temperature, but even prolonged soaking for several hours will effect the solution of only a small percentage of the carbides. Plate I illustrates the microstructure of stainless cutlery steel in the annealed condition. The carbides are very fine, but are clearly evident.

Plate II shows the structure of this same steel when quenched from about 1575° F. The white patches represent martensite, in which the carbide is dissolved, but it will be seen that only a small percentage of the surface is hardened.

When the hardening temperature is

PLATE IV

Hardening temperature raised to 1750° F. The majority of carbides have been dissolved.

raised to 1650° F., a much larger percentage of the carbides has gone into solution, but the steel is still far short of being thoroughly hardened. (See Plate III.)

At 1750° F. (see Plate IV) a majority of the carbides have been dissolved, but there are still plenty left out of solution to cause corrosion under severe corrosive conditions.

When the hardening temperature reaches 1825°/1850° F., the solution is complete as illustrated in Plate V, and the steel is then fully stainless and fully hard.

Iron oxide or scale is electro-negative to stainless steel. Rust is also electro-negative to stainless steel. Since it is impossible to harden steel commercially without scaling the surface, the hardened article with the scale attached will quickly rust if placed out of doors. It is, therefore, necessary to grind, polish, sand blast, or pickle the surface of the hardened article in order to remove every trace of scale. If a few pits of scale are left, electrolytic corrosion will start at these points, and as the steel around the scale rusts, this rust will set up further electrolytic action and the corrosion will eventually spread over the entire surface. It is very important to remember, therefore, that all non-corrosive steels exhibit their maximum non-corrosive properties only when a clean metallic surface is presented.

Stainless cutlery steel, when properly hardened and drawn, possesses physical properties comparable to the best grades of automotive alloy steel. Stainless steel is somewhat similar to high speed steel in that the hardness produced on quenching is not materially reduced until the drawing temperatures are quite high. Plate VI illustrates the average physical properties which may be secured upon hardened stainless steel by drawing it back at various temperatures between 500° and 1300° F. It will be noticed that the curves are relatively flat for drawing temperatures up to 900° F., and above this the physical properties and hardness fall off rapidly as the drawing temperature is increased. Drawing, as it progresses in the higher range, naturally precipitates the carbides from solution in a very finely divided form, but as soon as this process begins, the stainless properties of the steel begin to fall off, so that a curve showing the effect of drawing temperature on stainless properties would have practically the same form as the scleroscope hardness curve given in Plate VI.

It must be remembered that stainless steel will never corrode like ordinary steel, and even with drawing temperatures as high as 1100°/1200° F., stainless cutlery steel will not rust under ordinary atmospheric conditions, but will be slowly attacked by salt water.

Before leaving the subject of stainless cutlery steel, mention should be made of the usefulness of this same type of steel when the carbon is reduced to about .10 per cent, the chromium remaining at 13.00 per cent. This is known to the trade as "Stainless Iron," and since it contains only one-third of the eutectoid carbon, it may be likened structurally to a .30 per cent carbon machinery steel. Stainless iron is somewhat more non-corrosive than stainless cutlery steel when in the annealed condition, due to containing less carbon and therefore containing more chromium in the matrix. Even this analysis, however, is greatly improved by hardening to dissolve the carbides. Stainless iron is being used for parts which do not require excessively high physical properties or hardness, but where ductility is highly important in the fabrication of the finished article. Stainless iron is being used for deep-drawn parts of all sorts, cooking utensils, turbine blades, sheets, etc.

Stainless cutlery steel has found extensive application for table cutlery, surgical instruments, dental instruments, pump shafts, valve parts, ball bearings, electrical appliances, parts for carburetors, water meters, washing machines, automatic refrigerators, soap and paper machinery, etc. There are, however, many uses for non-corrosive steels where great hardness and high physical properties are not necessary and where hardening and finish grinding are not only unnecessary but objectionable. This need has precipitated the development of non-corrosive steels which do not require hardening.

Bearing in mind the corrosive factors enumerated in the early part of this article, it is necessary that such a

PLATE V

Hardening temperature 1825°/1850° F. The solution of the carbides is complete.

steel should be insoluble in water and other corrosive liquids, and must not be subject to electrolytic action. Since the steel must contain some carbon (and hence some carbides), and since it is not to be hardened, the only thing available is to add some element which will equalize the potential between the matrix and the carbides. Chromium itself is electro-negative with respect to iron, so that if we hold the carbon at .30 per cent and add more chromium, this chromium will be taken up entirely by the matrix and will greatly diminish the electrolytic effect. Copper is highly electro-negative to both iron and chromium, and small percentages of copper can, therefore, be added which will completely neutralize the electrolytic action between the carbides and the matrix. This reasoning was responsible for the development of a new type of steel containing:

Carbon .30% Chromium 20.00%
Copper 1.00% *

* This is a proprietary analysis sold under the name of "Carpenter Rustless Steel."

(*Continued on page 124*)

Rubber

A story of the industry, including a description of the processes from the raw material to the finished product

By HENRY R. GILSON, '01
Technical Assistant to the President, United States Rubber Co., New York, N. Y.

CHRISTOPHER COLUMBUS, on his second voyage to this country, subsequent to 1492, landed on the Island of Haiti and collected among other curiosities some strange, black balls given him by the Indian boys, which were made from the hardened juice of a tree. What he did with them is not known.

In the next century after Columbus' travels, the Portuguese founded the Colony of Brazil, and the first journey down the Amazon River was made by a Portuguese missionary. He found the same gum-tree juice that Columbus had in the West Indies, but here the natives had discovered that it was waterproof, and they made shoes that would keep out water.

Little by little, samples of this new substance found their way to Europe, but it was 1731 before thoughtful men believed it worth while to investigate this gum, and the Paris Academy of Science sent explorers to learn about it. It was not long after this that Lisbon began to import crudely fashioned articles, and it is said that in 1755 the King of Portugal sent several pairs of royal boots to be waterproofed.

About the year 1770 a black ball of this caoutchouc found its way to England, and Priestley, the discoverer of oxygen, learned it would rub out pencil marks. He named it "rubber."

In 1800 Brazil was the only country manufacturing rubber articles, and her best market was North America. Rubber shoes, water bottles, powder flasks, etc., found buyers in American ports, but rubber shoes were most in demand.

Soon after this America began to import raw rubber and manufacture goods of its own. A Scotchman named McIntosh, operating in England, found a way of waterproofing by spreading a thin sheet of rubber dissolved in naphtha between two strips of cloth. His name still stands for raincoats today. The trouble with these materials as made at that time was that in Winter the shoes and coats got very stiff and hard, and in the Summer soft and sticky.

Discovery of Vulcanization

About 1834 Charles Goodyear, a Connecticut hardware merchant, began the study of rubber, and it became a passion with him. He set out to find a method that would make rubber goods impervious to change of temperature. He neglected his business, pawned his goods, and borrowed from his friends. With an inventor's tireless patience he tried one combination after another, but they all failed. Finally, in 1839 it is said, when he was mixing rubber and sulphur together, he accidentally dropped a spoonful on a hot stove. Instead of melting, as he expected it to do, it flattened out like a silver dollar, and when removed from the stove bent and stretched easily without cracking or breaking. This was the first discovery of vulcanizing, which Brockedon, an Englishman, later named after the Roman god of fire.

In 1844 Goodyear took out the first of more than sixty patents which were granted to him for applying his original process to various uses. From the moment of Goodyear's discovery, the successful future of rubber was certain. Today probably 50,000 articles make the manufacture of rubber one of the greatest industries in the world.

CLOSE-UP VIEW OF TAPPING
The bark is cut with a tool somewhat like a gouge. The juice is collected in enamel cups.

Origin of Rubber Plantations

About 1870 H. A. Wickham, an Englishman living in South America, conceived the idea of cultivating rubber trees. He planted some seeds from the Hevea tree around his Brazilian home and started a tree nursery. He published some of his ideas, and a copy of the book came into the hands of the Director of Kew Gardens in England, who thought his plan worth trying. In 1876 Wickham carried a supply of seeds to England and they were planted under the glass roofs of the Kew Gardens hot houses. When these plants had matured enough, several thousand were shipped in small glass-covered boxes to Ceylon, Singapore, and other British Possessions. There they were planted in Botanical Gardens and received the greatest care and attention. After five years, when the trees were tapped, the yield of milk proved Wickham's dream a reality.

Now, rubber plantations are located in Ceylon, Malaya, Java, Sumatra, and Borneo, as well as in the warm belt of South and Central America. It was not because of the fear of the wild rubber supply giving out that these plantations were started, for in the Brazilian forests alone it is estimated that there are perhaps 300,000,000 trees untouched. The difficulty of securing labor, of getting the rubber out of the jungle, poor transportation, and unhealthy living in the undeveloped country were the main reasons for plantation development. Then, too, cultivated rubber comes to America far cleaner and with lower percentage of waste than the wild rubber.

The first five years of a plantation is a time of anxious waiting, for until the trees have reached this age they are not ready to be tapped. The yield is slow, not more than three-quarters of a pound of rubber coming from a tree in its first year, but it increases steadily. The average yield is about four pounds a year. In working a plantation the rubber gatherers start soon after it is light, for the milk does not flow as freely a few hours after sunrise. Each one carries a tool somewhat like a gouge, which is used to cut a shaving of bark, from which the juice trickles into enamel cups placed for it. There are several ways of tapping — the V, the half V, the herringbone, the half herringbone, the spiral, and others. The milk is collected all the year through, but it is deemed advisable to rest the trees by perhaps tapping only on alternate periods. There are approximately 350 rubber-producing vines and trees, but the largest producer of pure rubber is called the Hevea. This tree grows to a height of about sixty feet, and when full grown is eight or ten feet around.

Process of Making Rubber

In collecting the latex the natives pass among the trees and empty the milk from the little cups into cans, which are taken to a central collection station and emptied into a large tank. From this station tank wagons take the latex to the factory, where the rub-

ber is extracted. The different plantation methods of obtaining the rubber from the latex will be described farther on.

In the jungles of Brazil the native builds his hut of poles with a thatched roof and makes it his home for a six-months period. His first task is to chop out the jungle and make paths from tree to tree, which may be ten to seventy-five feet or more apart. This path is a sort of loop connecting one hundred trees or more, both ends of the loop being at the hut. The trees are then tapped. The average yield of a matured tree is about six ounces per day. During the morning the native makes his round with pails or cans and brings the milk back to his hut. Over a fire of wood and nuts he places a crude funnel with the small end at the top. Then he dips a wooden paddle into the milk and holds it over the thick, black smoke that comes from the top of his furnace. The milky coating soon becomes a yellowish color. He then again dips the paddle in the milk until a large number of layers have been formed. The amount of latex coagulated in this way will produce five or six pounds of rubber per hour. When completed, the lump of rubber, which is called a biscuit or ham, may weigh as much as 150 pounds. These biscuits are then taken to headquarters, weighed and credited, and the rubber shipped down the river where it is sold. It can be seen that this method of collecting rubber is very crude, but in spite of this it is still considered one of the highest grades of rubber. It is known as "Fine Para."

In contrast to this, the plantation methods are a revelation. There are several methods in use, notably: natural coagulation method, the acetic acid method, and the spray process, the latter being a recent development.

Natural Coagulation Process

In the natural maturation method, the coagulation of the latex is brought about by letting it stand in pans at normal temperatures a sufficient length of time to bring about coagulation in much the same manner as cow's milk will form into a clot after it has become soured. After coagulation the coagulum may be completely dried or it may be shipped containing ten per cent or fifteen per cent moisture. In the latter case the coagulum is passed through rolls, to squeeze out the serum or water, is sheeted, and allowed to partially dry. Whether shipped wet or dry, this method results in a rubber which has a disagreeable smell. In the case of the natural coagulation method more of the non-rubber constituents are retained in the rubber at the start, but where a considerable percentage of moisture is present, these decompose during transit and are practically all washed out in preparing the rubber for use at the factory.

Acetic Acid Process

In the acetic acid method of coagulation, the latex is collected, brought to a central station, and emptied into tanks of proper size. A dilute solution of acetic acid is then added to the latex, and the latex gently agitated so as to obtain a thorough distribution of the acid. After a period, depending upon the strength of the acid solution, coagulation takes place and the rubber contained in the latex coheres in a wet, spongy mass, which is known as coagulum, leaving a more or less clear liquid which is called the serum. The serum contains a large portion of the water-soluble ingredients of the latex and also a small amount of uncoagulated rubber particles. In some instances this serum is collected and subjected to a subsequent coagulating process in order to obtain the entire rubber constituents of the latex. No matter how well the process may be carried on, a number of the non-rubber constituents are lost in the serum, as well as some of the rubber particles.

The spongy mass or wet coagulum is then passed through rolls, to squeeze out the serum liquid, and then is sheeted and dried. In making Smoked Sheet the same process is followed, except that the drying is carried on in a smoke chamber for ten days to two weeks usually, after which the rubber is baled and prepared for shipment. Crepe is made by running the rubber through roughened rolls.

Spray Process

The spray process, or mechanical method of extracting the rubber from the latex, is the latest commercial method of producing crude rubber from latex. The type of equipment for producing sprayed rubber which has so far given the best results, and which is now being used, is known as the disc spray. In this process the latex is fed onto a rapidly revolving, horizontally mounted disc, from which it is thrown in an umbrella-shaped spray or mist into a heated current of air or gas. The disc is located at the top of a tower, generally of the shape of a hollow pyramid, and the fine spray of rubber globules falling through the hot gases settles on the bottom of the unit as a dry, creamy white, spongy mass, which has approximately one-third the density of ordinary crepe rubber. A current of hot air is forced in at the top of the tower, passes downward through the spray or mist of latex, and escapes at the outer edges of the bottom of the unit, carrying the moisture which was in the latex with it.

The rubber globules are dried almost instantly and the rubber shows no harmful effect whatever from the heat required for evaporation. The heat is applied from an oil-burning furnace, and the temperatures at the entrance and exit of the spray unit are easily and carefully controlled. The capacity of the spray unit so far developed runs about 400 pounds of dry, evaporated rubber per hour, which varies with the total solid content of the latex used. This process of making rubber from the latex is continuous, since the bottom of the unit consists of a movable platform by means of which the dry, spongy rubber is removed from the floor to the baler. The rubber, which is creamy white when deposited, takes on the appearance of brown crepe when compressed in a bale. The compressed bale of rubber is then either boxed or wrapped in burlap, the average of the bales being about 200 to 250 pounds.

JUNGLE VIEW IN THE SUMATRA FORESTS
This jungle must be cleaned before the rubber trees are planted.

The advantages of sprayed rubber are absolute cleanliness, uniformity due to bulking large quantities of latex (this reduces the desirability of blending so long considered necessary), greater tensile strength, quicker curing, better ageing, etc.

Trade Names of Rubber

A variety of names has been given to different grades of rubber, among which may be noted Pale and Brown Crepe, Smoked Sheet, Gristley Crepe, Nigger Heads, Cameta, Para, Caucho Ball, Benguella, etc.

Rubber versus Gutta Percha, Balata, Chicle

The terms rubber, Gutta Percha, Chicle, etc., are so commonly used that a brief description of each may not be out of place. We have already shown the sources and preparation of rubber. Gutta Percha comes from one of the Sapotads, a tree which is botanically unrelated to the rubber-bearing species. It is found on the Malay Peninsula, Borneo, Sumatra, and neighboring countries. The gum, ordinarily the result of the latex which flows from the tree, is also to some extent extracted by mechanical means, and by the aid of solvents, from leaves and other parts of the tree. Until within a few years the most common mode of obtaining Gutta Percha was to select the finest tree, cut it down, and strip off the bark. Between the wood and bark a milky juice was found which was scraped up in little troughs made of leaves. The milk, as it flows from the tree, is snow white, but darkens on being exposed. Like rubber, a thick cream forms on top of the milk when allowed to stand, and coagulates by gentle heating. This is removed, molded into cakes, and thrown into boiling water, from which it emerges ready to be shipped. A start is being made to create Gutta plantations.

Gutta Percha differs very materially from rubber, the former being non-elastic, or elastic only to a small degree. It is adapted for cable coverings, especially for submarine work. It also has surgical, chemical, and mechanical uses.

Balata

Balata has its place of origin in Venezuela and the Guianas; also, to some extent, in Brazil. Gums passing under the name of Balata, but differing somewhat from Venezuela, especially in the associated resins, are imported from the Amazon Valley, West Africa, and elsewhere. Balata contains about thirty-nine per cent of Gutta-like material and no rubber. It is midway between rubber and Gutta Percha as regards elasticity in the crude state. East Indian Gutta Percha is hard like wood, Balata is springy like whalebone, while rubber is still more springy.

TAPPING ON A RUBBER PLANTATION

A shaving of bark is cut from the tree and the juice is allowed to trickle out. The average yield from a tree is about four pounds a year.

Balata is just as truly a Gutta Percha as a lesser grade of rubber is rubber. Because of its great strength it is especially suited for the manufacture of certain beltings, covers of golf balls, etc.

Chicle

Chicle is a Central American Gutta Percha, a resinous gum derived from the milky latex of Nispero, an evergreen tree which grows abundantly in the warm, damp forests of Southern Mexico, Yucatan, Central America, British Honduras, and adjacent South American countries. The latex from which Chicle is prepared occurs in the bark of a tree like rubber, and is obtained by tapping in much the same way as rubber or Balata. The latex is conveyed to collecting camps, where it is boiled down in large vessels to a dough-like consistency, kneaded to remove some of the water, and pressed in wooden molds for transportation.

Crude Chicle is quite hard, brittle, and easily reduced to fragments. It varies according to purity from a light to a dark brown color, and melts readily with heat, being easily softened when held in the mouth. When warm it is ductile and adhesive without perceptible odor or taste, and it is entirely free from any injurious qualities. It is used mostly in the Chewing Gum Industry.

The Rubber Industry

The most extensive use of rubber in the world is in tires. About seventy-five per cent of the United States consumption is so used. The estimated consumption of the world in 1925 is over 500,000 tons. Of this probably in excess of ninety per cent will be derived from the plantations in the Middle East. The importance of the rubber industry in the United States may be gathered from the biennial Census of Manufactures for the three years given:

Year	No. of Establishments	Capital	Value of Products
1919	477	$960,070,000	$1,138,216,019
1921	496	Not reported	704,903,133
1923	528	Not reported	953,643,355

The so-called European plantations constitute 2,800,000 acres, or about two-thirds of the whole, and represent a capital investment of $765,000,000, of which Great Britain controls $489,000,000; Netherlands, $130,000,000; Japan, $40,000,000; United States, $32,000,000; France and Belgium, $27,000,000; and others, $47,000,000.

Latex

In view of the increasing importance of latex as such in this country, a brief description of this material may not be out of place.

Mention has already been made of how the latex is obtained from the rubber tree. The percentage of rubber in latex varies with different trees. This variation will generally come between twenty-five per cent and thirty-five per cent by weight. As the latex is taken from the tree and placed in the collecting tanks, a certain amount of preservative to prevent coagulation is added. Among the substances tried as preservatives are hexamethylenetetramine, formalin, sodium bisulphite, sodium fluoride, ammonium polysulphide, ammonium carbonate, and ammonium hydroxide, etc. Of these, formalin and ammonia appear to give the most satisfactory results.

Where it is desired to preserve latex for a period of time sufficiently long to ship it to this country in its liquid

(*Continued on page 128*)

Progress in Steam Railroad Electrification

Recent electrification projects discussed—Steam and electric operating costs compared—Oil electric and gas electric locomotives described

By W. D. Bearce

Railway Engineering Department, General Electric Co., Schenectady, N. Y.

THE interest of steam railroad operating companies in various parts of the world in proposals to utilize electric locomotives received a considerable impetus in 1915 and 1916 from the unusual example of the Chicago, Milwaukee & St. Paul Railway. Following a most successful demonstration of high-voltage direct-current equipment by the Butte, Anaconda & Pacific ore lines, this road was just then completing the electrification of four main line transcontinental divisions, totalling 440 miles in length. The trolley potential (3000 volts) was at that time the highest direct-current voltage to be used for heavy traction.

Commissions from various foreign countries and individual consulting engineers have made exhaustive studies of this electrification, and all have been impressed with the remarkable success of the project. As a result, 3000 volts is now being used for railroad operation in many parts of the world. The first use of this high voltage outside of the United States was in Brazil, where the Paulista Railway has electrified one of its main line double-track sections. In Chile, also, the Chilean State Lines in 1923 converted the entire main line section between Santiago and Valparaiso. Another interesting 3000-volt, direct-current installation was made in the north of Spain over a severe two per cent grade section of the Spanish Northern Railway in the Cantabrian Mountains. Another most important electrification is that of the South African Railway, where no less than 172 route miles are just beginning operation. In Mexico the most difficult section of the Mexico City-Vera Cruz line, operated by the Mexican Railway Co., Ltd., is beginning electrical operation handling both freight and passenger trains. The grades encountered (4½%) are probably the most difficult of any railroad handling such heavy main line traffic. On all of these lines it is of interest to note that regeneration is used for holding trains on the grade sections. Another 3000-volt, direct-current electrification is being placed in service by the Moroccan Railways in Northern Africa. On this project, as well as on the South African Railway, the substations are automatically controlled.

As a result of the studies made by various engineers of American and other electrifications, a number of countries have selected 1500 volts direct current for their electrification work as being better suited to local conditions. The most important of these are France, which is electrifying a very extensive mileage; Australia, electrifying the Sydney suburban traffic; Japan, handling all classes of main line work; Bombay, India, electrifying heavy traffic suburban zone; and Java, for the conversion of a congested suburban district around the city of Batavia.

In the United States, electrification work has only been resumed very recently, since interruptions resulting from the World War. The Virginian Railway*, handling the heaviest freight traffic of any railroad in the world, is now being electrified, using the single-phase system similar to the paralleling lines of the Norfolk & Western Railway. The Illinois Central Railroad has placed orders for 1500-volt direct-current equipment, using multiple unit cars for handling the heavy suburban traffic out of Chicago. A similar project, but not quite so extensive, is that of the Staten Island Rapid Transit Railway, a subsidiary of the Baltimore & Ohio, handling heavy passenger traffic on Staten Island. New electric locomotives or car equipment have also been ordered by the New York Central, New York, New Haven & Hartford, the Baltimore & Ohio, and the Pennsylvania Railroads.

A most interesting comparison of steam and electric operating costs has recently been prepared by the officials of the Paulista Railway in Brazil. The results disclosed the costs of both steam and electric operation for a period of one year.

Briefly, the comparison is as follows:

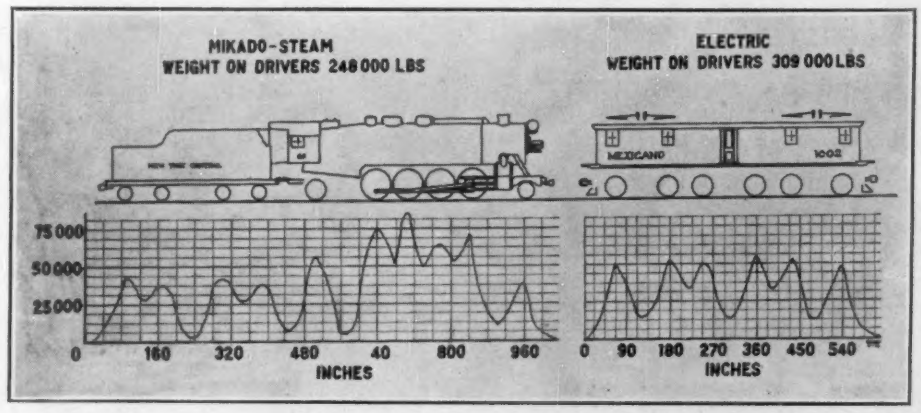
TOTAL COSTS ON THE BASIS OF A YEAR'S SERVICE OF 465,750 TRAIN MILES

	Cost per Train Mile	
	Steam	*Electric*
Operating Trains	$63.09	$19.30
Locomotive Repairs	6.83	2.18
Transmission Line Operation and Maintenance		.46
Trolley Line Operation and Maintenance		1.03
TOTAL	$69.92	$22.97

In other words, the cost of electric operation is about one-third that of steam. Analyzed in more detail, the cost of electric power is about one-fourth the cost of coal or wood; the cost of locomotive repairs is about one-third that of steam; and the entire cost of maintaining and operating the electrical system is only 6½ per cent of the total operating cost.

A new development which has aroused much interest among railroad men is the motor-generator type locomotive, taking high-voltage single-phase current from the trolley, converting it by portable substation equipment on the locomotive to direct current, which is used for driving standard geared type railway motors. Seven locomotives of this type have been ordered by the New York, New Haven & Hartford Railroad, and Mr. Ford is building two units for the Detroit, Toledo & Ironton, using the same principle. The motor-generator locomotive is being tried out with the idea of taking advantage of the well-known qualifications of the direct-current series motor for traction work on locomotives operating under a single-phase trolley.

(*Continued on page 126*)



OTHEOGRAPH RECORDS

Steam and electric locomotives, showing vertical forces on track. Speed, forty miles per hour.

* Article on the Electrification of the Virginian Railroad appeared in the April issue of THE TECH ENGINEERING NEWS, Vol. VI, No. 1.

Recent Books

This department conducted in co-operation with the Technology Library

Physico-Chemical Evolution. By C. E. Guye, Professor of Physics, University of Geneva. Translated by J. R. Clarke, Assistant Lecturer in Physics, University of Sheffield. New York: E. P. Dutton & Co., 1924.

The author of this book has summarized in simple language the facts of science and life which bear upon the problem of evolution of life. His present aim, however, is not the solution of this problem, but rather the presentation and description of a scientific tool to aid in the solution of the problem. In mathematical language it is the theory of fluctuations in the calculus of probabilities. After defining and classifying the sciences in the first chapter, he devotes the second chapter to describing the phenomena of fluctuations. A simple comparison is made with the game of roulette. To use the words of the author: " 'On the average' the longer a player continues to play the greater are his chances of enriching or of impoverishing himself; but this enrichment or this impoverishment is not proportional to the time for which he plays, but to its square root. This result appears to be peculiar at first sight, but it is explained by the fact that compensation spins occur in long series which generally do not arise in the shorter series. In the second place, we see that the ratio between the number of spins on which a player has won or lost, and the number of winning or losing spins which the chance of the game assigns to him, is nearer to unity the larger the number of spins in the series." "To sum up: though the player's gain or loss increases 'on the average' as the game is prolonged, the ratio of the number of spins on which he has won to the number of spins on which he has lost tends toward unity. In addition this ratio does not affect the state of the player's bank; only the absolute value of the fluctuation at the end of the series enriches or impoverishes him. These considerations will permit us to attack the problem of fluctuations in physical chemical phenomena, etc."

Several examples of fluctuation in physics and chemistry are mentioned, such as the opalescence at the critical point, the blue of the sky, the displacement of particles in Brownian Movement. In biology the average ratio of masculine to feminine births is approximately 1.05, whereas in different countries the ratio fluctuates slightly. The author states that the law of evolution of matter is that matter always tends to a state of greater probability. Thus in physics and chemistry the second principle of thermodynamics, or Carnot's principle, is the law of evolution of matter, due to the fact that extremely large numbers of atoms and molecules are used in experimentation. The fluctuations tend to become negligible.

In the final part of the book these considerations are applied to changes in living creatures. The author states the views of Helmholtz as follows: "The vital equilibrium will be due then to the fact that chemical reactions in the interior of a living organism will no longer follow necessarily the evolution which tends to make the system change to a more probable state." "At the death of the organism, the vital principle being exhausted or absent, our statistical laws will again resume their operations with the quasi finality which characterizes them." The views of the author may best be presented in his own words: "If we consider the problem from the point of view of classical thermodynamics, that is to say, if we regard Carnot's principle as an absolute principle, we find no scientific reason for supposing that this principle is not applicable to the physico-chemical evolution of living organisms."

But since the researches of Gibbs and Boltzmann, Carnot's principle has received a less absolute interpretation: it is considered as a statistical principle which allows us to remain in ignorance of the laws governing the individual actions between atoms, molecules, and electrons.

In addition to those laws of physico-chemical evolution which arise from Carnot's principle, and which only express the most probable evolutions, there is room, in certain particular cases, for other very rare possibilities, namely, fluctuations.

In general, the relative importance of these fluctuations becomes greater as the number of molecules contained in the homogeneous element of volume considered becomes smaller. Further, they may become exceptionally important at certain particular points in the physico-chemical evolution of a system.

Now the fine structure of living matter, which can be conceived to be formed by the juxtaposition of very small homogeneous elements, seems to be particularly favorable to the appearance of fluctuations. Thus we are led to believe that the caprice of fluctuations may very well have some effect on cellular physico-chemical evolution, and even on the development of living beings, if these are considered as the result of cellular proliferation.

The physical chemistry of living beings, which is usually termed physiology, can therefore be considered, from this point of view, as a more general physical chemistry than our physical chemistry *in vitro*; in the sense that when it is applied to extremely differentiated media the statistical fluctuations are no longer entirely negligible: they derange the simplicity and the exactness of our physico-chemical laws.

A unicist philosophy based upon Carnot's principle is outlined. The author summarizes the results of his study as follows: "The physico-chemical evolution governed by Carnot's principle is due to statistical actions, but the cause and the origin of the organization of life and thought must be sought in individual actions." R. H. GERKE.

The Metallurgy of Aluminium and Aluminium Alloys. By Robert J. Anderson. New York: Henry Carey Baird & Co., 1924.

It is always gratifying when a great need is satisfied. No standard work on aluminium has appeared in English since the treatise by the late Dr. J. W. Richards in 1896. The work by Dr. Anderson is therefore enthusiastically welcomed by all interested in aluminium and its alloys.

The author brings to his subject a wealth of practical experience which has enabled him to present a well-rounded text. Every phase of the subject is covered, from the mining of the bauxite to the casting and fabrication of finished products of the metal and its alloys. The book contains 881 pages, which, at first thought, seems large. But in reading through it one does not get the impression of verbosity. There is little which could be omitted without a distinct loss to some phase of the subject.

The book is divided as follows: Introduction and Historical Discussion, 30 pages; Bauxite and Bauxite Mining, 42 pages; Production of Aluminium, 63 pages; Physico-chemical Properties of Aluminium, 53 pages; Corrosion of Aluminium and Aluminium Alloys, 33 pages; Alloys of Aluminium, 46 pages; Uses and Applications of Aluminium, 59 pages; Preparation of Aluminium Alloys, 51 pages; Aluminium and Aluminium Alloy Melting Practice, 51 pages; Production of Secondary Aluminium, 44 pages; Aluminium Alloy Foundry Practice, 47 pages; Casting Losses and Defects in Castings, 59 pages; Production of Die Castings, 48 pages; Rolling and Other Mechanical Treatment of Aluminium and Aluminium Alloys, 53 pages; Diagrams of Thermal Equilibrium, 48 pages; Micrography and Macrography of Aluminium and Aluminium Alloys, 32 pages; Heat Treatment of Aluminium, 50 pages; Soldering and Welding Aluminium and Aluminium Alloys, 32 pages; Drawing and Other Fabricating Operations, Finishing, Machining and Electroplating, 30 pages.

Each of the chapters contains a selected bibliography which will be of great value to the student who desires more details on various subjects.

There are 295 illustrations which are well selected, but unfortunately the cuts in most cases give evidence of having been poorly prepared, which greatly detracts from the general appearance of the book.

It is unfortunate that more details could not have been given on production operations. The reasons for this are well known and the author cannot be held responsible.

Aside from the two deficiencies mentioned above, the book is deserving of unreserved praise and the author is to be congratulated.

Users of aluminium and light alloys will welcome the compilation of data on the equilibrium diagrams, the properties of numerous alloys, and a description of various present uses of these materials.

Those who are engaged in the production of aluminium alloys will find the chapters on melting procedure and foundry practice of value, as well as the discussion of casting losses and defects. The author calls liberally on his own experience in these fields and cites numerous examples of failures with their supposed causes as well as precautions requisite for success.

The chapter on heat treatment reflects the present state of the art. There are still conflicting theories which are cited and discussed, but it is evident that a more exact knowledge is needed on this subject.

The rapid increase of knowledge regarding aluminium and its alloys will impose a serious task on the author of this excellent work in keeping it up to date.

The longer and more scientific spelling, "aluminium," used by the author has been retained in this review, but many will regret that he does not use the shorter and more commonly used form of the word. CARLE R. HAYWARD, '04.

Industrial Coal: Purchase, Delivery, and Storage. A report of American Engineering Council. New York: Ronald Press Co., 1924. 419 pp.

Interruptions and losses in American industry because of an inadequate and unstable coal supply are frequent and serious. Recognizing this as a vital industrial problem, the American Engineering Council appointed in March, 1923, a committee on Storage of Coal, to make a thorough study of the coal situation, particularly as regards present methods and cost of distribution and storage.

The committee conducted a comprehensive investigation, with the aid of local sub-committees, in practically every important industrial center in the United States, and the present volume is its report. It finds present storage methods wholly inadequate, and recommends seasonal storage by consumers as essential to the stabilizing of the coal industry.

The Microscope. Part 2: an Advanced Handbook. By Conrad Beck. London; R. & J. Beck, 1924. 231 pp. Illus.

This volume supplements "The Microscope: a Simple Handbook," now reckoned as Part 1. It is an endeavor to explain the theory of the microscope without the use of advanced mathematics or elaborate scientific details.

(*Continued on page 134*)

Here and There

Humorous notes from the Editor's desk

HELEN MARIA

The name of Helen has often featured in the world's news, from Helen of Troy to Helen Maria Dawes. Now the name of Helen again rings across a continent.

Helen F. Cole, young, pretty, blonde-haired, blue-eyed, is Cleveland's first aerial heroine, a girl as nervy as she is attractive. Seated beside the pilot in a 4-place Dayton-Wright Cruiser, carrying two Press photographers to the wreck of the *Shenandoah*, this fair Helen of Ohio noticed the pilot was in difficulties when the plane was over Ava. He pushed the control stick back and forth — and nothing happened to the elevators. As he kept the plane level with the adjustable stabilizer, he did some high-powered thinking, and decided a tapered pin must have slipped out of the controls at a point behind the bulkhead back of the rear seat. He told the girl of the trouble, and indicated how, by lying sideways on the floor of the cockpit, she could reach through a port in the bulkhead, find the pin, and put it back.

The intrepid girl, as cool as an Eskimo pie, calmly nodded and did as suggested. She found the pin and held it in place, lying cramped on the floor while the pilot flew to Duncan Falls and landed. I maintain that a girl like Helen Cole is the answer to the Pilot's Prayer. And I wish I could finish this story in the same romantic vein in which I tried to write it — but the sad ending is: The pilot who flew that plane was Kenneth R. Cole, her husband. — *Aviation.*

RAH-RAH-RAH!

There is a real reason why college cheers so frequently contain the word "Rah." According to studies made by Dr. Irving B. Crandall and Mr. C. F. Sacia of Bell Telephone Laboratories, men ordinarily speak this sound louder than any other vowel. If the value of 50 be assigned to the amount of energy delivered by a man's voice to the air for this particular sound, then its nearest rival, the sound of "a" as in "tap," comes next at 44, and as in "talk" at 37.

Women's voices present quite a contrast to men's in that there are four vowel sounds of practically the same loudness. These are the vowels in "tone," "talk," and "rah." "Ah" is the easiest sound to produce because fewer throat and mouth muscles are tensed, hence it is the basic vowel sound in most languages.

AWAY WITH WEIGHT

By Berton Braley

The Dinosaur and the Stegosaurus
Have lived and died and gone before us,
For they were heavy and inefficient,
And Fate or Nature or God omniscient
Buried them deep, in a by-gone time,
Under the Paleozoic slime;
For they were clumsy and huge and slow,
And naturally they had to go.

The power units first built by man
Were made on the Paleozoic plan,
For they were heavy and slow of movement;
We make 'em lighter and swifter, too,
Till a pound of engine today will do
What once was done by a ton — and so
Those earlier monsters had to go.

And now the power that we require
Goes purring over a strand of wire,
And doubtless presently it will fare
Like radio energy — through the air.
And if the scientists should succeed
In splitting the atom, then, indeed,
Our modern power will seem so slow
That it will certainly have to go.

And all our methods will then be linked
Along with mammals and birds extinct;
The heavy engines that went before us
And the Dinosaur and the Stegosaurus!

— *Power.*

REAL HEROISM

While there must be many cases of heroism by engineers in the line of duty, it is seldom we find one exhibiting such a high degree of personal bravery and devotion to duty as this instance reported by *Power* by Ancel M. Salyars, of the Gas & Electric Co., Heavener, Okla.

Mr. Salyars is superintendent of the Gas & Electric Company, and is also in charge of the pumping station that supplies the water to the town.

On Christmas night a water-valve froze and burst, flooding the motors in the pump-pit. He worked for hours trying to stop the leak, without any success. There was a valve under the river which, could it be opened, would drain the pit. But the river was frozen over. The young superintendent took a pick, cut a hole in the ice, and dived down to the drain valve. He tugged at it until he finally got it open. He then set to work, in his frozen clothes, to dry out the motors, and started the pumps to work again, which took the rest of the night.

MULES DEADLIER THAN PLANES

Despite newspaper reports to the contrary, airplane accidents are less in number than those due to other causes. Speaking before a conference of aeronautical and business officials at the Ford Airport, Dearborn, Mich., Maj. R. W. Schroeder, A. S., U. S. A., former chief test pilot of the Army Air Service at McCook Field, recently said:

"A man in a plane engaged in ordinary straightaway flying is safer than on the ground. I have noted that during a recent year eight persons lost their lives in the entire United States while engaged in civilian flying, while during the same year, in the State of Missouri alone, eighty persons — just ten times as many — were kicked to death by mules."

QUEER CARGOES

In a recent issue of *Marine Engineering and Shipping Age*, under the title of "New Sources of Ocean Commerce," they mention some cargoes that sound rather odd. One was 3,450 tons of dried prunes which left San Francisco for Hamburg, Germany. In another place, they speak of a shipment of 3,000 tons of dried eggs recently received in New York from China. I suppose our custard pies will be made of dried eggs from now on. Incidentally, there is an article in this issue telling how they mixed blood powder with dried eggs to make something which we are supposed to eat. All this is very illuminating from the point of view of ocean shipping, but it is more illuminating from the view of our daily ration.

"I'S A COMIN'"

At a recent meeting of one of the engineering societies, a group of men were discussing the difficulties of "bringing in" an oil well. One of them told of a well that came in with the liberation of a large volume of gas. A small gasolene engine found the heavily charged atmosphere sufficiently rich to propel it, and ran away, notwithstanding its governor had shut off its legitimate source of fuel supply. In an effort to stop it, the man in charge pulled the ignition switch, drew a spark, and lighted the atmosphere. When those present came to and called the roll, they found everybody accounted for but one negro. Some twenty minutes later even he appeared. When asked where he had been, he replied, "I been comin' back."

— *Power.*

Professional Notes

Activities of the Undergraduate Engineering Societies at the Massachusetts Institute of Technology

NAVAL ARCHITECTURE SOCIETY

Though confined to a few men, for obvious reasons, the activities of the Naval Architecture Society are very interesting, and it is the endeavor of the Executive Committee to keep them that way. It is the purpose of the Society to obtain as much as possible of the actual workings of things by observation as well as by instruction by discussion and lectures.

During the past year there were not, perhaps, as many trips as might have been desired. There was the trip to the *Leviathan*, while she was dry-docked in South Boston. Through some mistake, all who went were not admitted, and to those who were, the chief source of interest was denied, namely, the engine and boiler rooms. Later in the year a trip to the Fore River Shipyard was undertaken and was only partially successful. The last trip, however, to Lawley's, was enjoyed by everyone. This foremost of yacht yards is full of interest, and the trip, which was supervised by Professor Owen, and aided by good weather, was a pleasure to all concerned.

A couple of smokers, and the Spring Banquet at the Sheraton, completed the year's activities.

This coming year we hope to offer to the Society a very full and interesting season. Instead of a few trips, with the whole Society participating, many trips of a few men each will be undertaken, and it is hoped that the interests and benefits derived in this manner will be handed around, and stimulate the Society to greater efforts. There are innumerable places, within easy reach, where a few men can drop around of an afternoon.

A more companionable and interesting Society is intended, with something besides the formal, technical trips. A sailing or a fishing party perhaps, or something of the sort, divided into congenial groups, to make the work of the Society a real and desirable fact.

CHEMICAL SOCIETY

Indications are pointing to a very prosperous year for the Chemical Society. Plans are well under way for a smoker and moving picture to be held late this month. It has not as yet been decided whether the noon luncheon meetings will be continued this year, due to the mediocre enthusiasm with which they were received. Any opinion on this matter will be given full consideration if such is addressed to any of the officers of the Society.

The Chemical Society offers to the Undergraduates an opportunity to get together and meet the men studying in the chemical courses at the Institute. This opportunity of close contact is particularly beneficial to the Freshmen and Sophomores, in that they are able to make the acquaintance of men about to go out into the engineering field. Aside from the social aspect of the Society, there is also the educational value. Trips are conducted regularly to the industrial plants in and around Boston. Smokers are held about every three weeks of the school year, and there are always two or three good speakers present. These men speak on current technical problems and achievements, which are of great importance and interest to the embryo chemical engineer.

The new officers of the Society, elected last May, are: D. H. McCulloch, president; P. L. Mahoney, vice-president; S. Cheney, treasurer; I. R. Macdonald, secretary; L. Billings, trip manager; C. R. Washburn and J. W. Searles, program committee.

MINING SOCIETY

The school year 1924–1925 was a very successful one for the Mining Society both from a professional and social viewpoint. The meetings were well attended and all agreed that the lectures were most interesting and instructive.

The subject-matter of the lectures was varied, ranging from personal experiences through technical discussions to advice to young men contemplating work in foreign fields. One especially interesting lecture, "The Struggles of the Seventies," dealing with the early history of Tech, was delivered by R. H. Richards, Professor Emeritus.

Amongst our other activities was a joint dinner with the Mining Societies of Harvard and Tufts, and a joint meeting with the Boston Section of the American Institute of Mining and Metallurgy. These meetings fulfilled a very definite purpose, that of making us acquainted not only with men who were as ourselves in the undergraduate stage, but also with men who have had considerable practical experience.

ELECTRICAL ENGINEERING SOCIETY

The Electrical Engineering Society looks forward to a year of interestingly varied activities. The first meeting of the Society will be held early in October, when Dr. Herbert B. Dwight, a new member of the department staff, will speak on the subject of "The Power Possibilities of the Niagara and St. Lawrence Rivers." Professor Dwight has long been connected with the Canadian Westinghouse Company, and has been a very prominent member of the American Institute of Electrical Engineers, being the author of a number of papers on electric power transmission, electric machinery, and kindred subjects. He was awarded an honorary degree of Doctor of Science by McGill University in 1924 in recognition of his many contributions to the art.

Last year, upon the initiative of the M.I.T. Branch, the American Institute of Electrical Engineers was urged to establish a prize for the best paper to be written by an enrolled student. This plan is now under consideration by the authorities of the A.I.E.E., and it is expected that the announcement of the actual establishment of such a prize may be made soon. In connection with this, three students have already agreed to give talks on technical subjects, and it is hoped that others will express their willingness to do likewise. It is felt that such work as this can do more than almost anything else to prepare the students to become active, valuable members of their professional societies upon graduation from the Institute.

AERONAUTICAL SOCIETY

Continuing its policy of presenting the greatest possible amount of aeronautic activity and information to its members, the Aeronautical Engineering Society has planned an extensive program of smokers and trips. Because of the popularity of the films illustrating the World Flight and the Aircraft Bombing Tests which were exhibited last year, the managing board is planning to increase the number of aeronautical films presented this year at the smokers.

The program of speakers, although not yet complete, will include air service officers and civilians actively engaged in flying, as well as designers and technical experts, who will describe the latest aeronautical developments in plane and motor design.

The usual opportunity for free flights over the city of Boston, which have proved so popular in past years, is planned, but it is also expected that greater activity in the air for its members can be arranged. Special admission to the field at local air meets will be had, and the members will be kept in touch with events at the Boston Airport. The construction of the Aero Society's Light Plane, the design and estimates of which are complete, is being held up until the results of the 1925 Light Plane Races are more carefully studied.

The Engineering Field

Excerpts from the leading professional and trade journals

Launching of the Lexington. The U. S. S. *Lexington* took the water at the Fore River plant of the Bethlehem Shipbuilding Corporation at Quincy on October 3d. This vessel, with her sister ship, the *Saratoga*, launched at Camden, N. J., in April, are aircraft carriers, and by far the largest ships built in this country. Their overall length is 888 feet, and extreme breadth 106 feet. To obtain their full speed of 33 knots, the engines must develop 180,000 h. p., giving them the most powerful machinery afloat. Sixteen oil-burning boilers supply steam for four 35,000 k. w. turbine generators which will in turn drive eight 22,500 h. p. electric motors on four shafts. The ships are to be armed with eight eight-inch guns in twin mounts and twelve five-inch anti-aircraft weapons. They will carry about seventy planes.

In preparing the launching arrangements, those responsible faced a double problem. Technology has a special interest in the matter in that Professor Keith, '05 of the Naval Architecture Department, was called upon to make the necessary calculations. In the first place, the great weight and size of the ship (launching weight 27,500 tons) called for special strength in the ways, cradles, and releasing gear. In itself, this involved no very new methods, but great care was nevertheless necessary and the arrangements were exceedingly thorough. The ways were of ordinary type, being merely increased in size, while the releasing gear consisted of four large triggers of the usual pattern held in place by hydraulic rams and with steel safety stops. As an additional precaution against premature release, an auxiliary trigger was placed on the outside of each of the ways. Hydraulic rams were set up at intervals along the ways to start the ship if the release of the triggers failed to do so.

The second and more difficult part of the problem arose from the very restricted body of water into which the ship had to be launched, and resolved itself into the necessity for stopping her within 200 feet of the end of the ways. It was estimated that a maximum speed of nearly fifteen knots would be reached. The checking of very large ships in a short space has frequently to be faced in British yards, but the problem in so aggravated a form was new in this country. The method adopted was one which had proved its efficiency on the Clyde, but data were lacking. Ten large heaps of chain were placed on the ground on each side of the ways, each heap being arranged in the form of a U, with the open end towards the water. A specially made wire-rope hawser eight inches in circumference was attached to the bow of each U and led to a pin connection on the side of the ship. It was thus necessary for each heap of chain to be turned over or inside out before being dragged along bodily. The slack portions of the wire ropes were suspended from the ship's side by rope hangers. The heaps of chain were so placed, and the lengths of the hawsers so adjusted, that the drags would come into play in succession, starting with the one nearest the water.

The arrangements worked perfectly. The auxiliary triggers were knocked out, to be followed a little later by the safety blocks of the main triggers. After a pause, the ship moved almost imperceptibly, gradually increasing her speed until she slid into the water and the wire hawsers one by one took up the strain. The chain drags ploughed up the sand beside the ways and finally brought her to rest exactly as planned, when a flotilla of tugs took charge of her.

A Quick-Acting Thermostat. The first basic patent relating to thermostats since the discovery of the bimetallic principle was taken out this summer and promptly purchased by a large electrical concern at a high figure. The patentee noticed the behavior of a furnace door that was made up of a frame and a thin piece of metal like a diaphragm. When the door became heated to a certain temperature, the diaphragm suddenly bellied outward, and when it could cool off, it sprung in again with a sharp snap, much like the bottom of an oil can when pressed. The possible application to automatic thermostatic control occurred to him, so he promptly patented the principle. The advantage over the old bimetallic thermostat lies in the fact that the action is so sudden and complete at very critical temperatures.

Metal Faced Plywood. The demands for a durable waterproof plywood during the War were met through the development of a blood albumin glue to be used in cementing the plies of wood together. The company which now manufactures plywood with this glue has taken another forward step and developed a method of cementing sheet metal to the plywood. The first product, using zinc-coated metal, facing plywood 0.3125 inches thick, was found to be fifty times as stiff and resistant to buckling as sheet steel of the same weight. After more experimenting, aluminum was used successfully. A third product uses corrosion-resisting Monel metal. Such panels are absolutely waterproof, no water being able to reach the wood or glue if the edges are protected, and the size of the sheets is limited only by the size to which the metal can be rolled. Panels 7 feet wide by 50 feet long have been produced.—*Aviation.*

Synthetic Rubber of exactly the same molecular structure as the natural product has not yet been produced, but a synthetic near-rubber, which seems capable of commercial production, has, the *Chemical Age* (London) tells us, a great commercial future.

Natural rubber is a derivative of isoprene, but the new synthetic product is a derivative of butadiene. The economical production of butadiene has been attained in two ways. One is through the cheap production of acetaldehyde from carbide and of ethyl alcohol from coke oven gases, then bringing the two into reaction to produce the butadiene. The other is through the use of butyl alcohol yielded in the fermentation of starch. The butadiene is converted into rubber by Dr. F. E. Mathew's process using metallic sodium. The synthetic product, butadiene caoutchouc, has the valuable characteristics of rubber, being very plastic, easily vulcanized, and having great elasticity and tensile strength and resistance to chemical reagents.

"Tentacular" Belting, introduced to the American trade late in 1924, obtains its excellent properties from its very remarkable construction. The belt comprises an oak-tanned leather backing, to the under surface of which are attached narrow, longitudinal strips of special chrome leather treated with tallow. These strips are held in position by means of hollow brass rivets. The depressions surrounding the rivet ends, combined with blind holes in the rivets, act as suckers during use and increase the very high adhesion of the strips. The belting has, normally, the high coefficient of friction of 1.50, which permits a correspondingly low tension of the belt. This low tension, when used in the "tension formula" for obtaining horsepower, shows this belting to have a very great advantage, in transmission, over ordinary belting of the same specifications.—*Industry Illustrated.*

Diesel Electric Locomotive. When the roads operating the fifteen or so steam locomotives yet within the limits of New York City were recently faced with legislative action compelling the substitution of some smokeless form of engine, electrification seemed the only solution of the problem. But the same reasons that have prevailed until now still make such a step undesirable. The time limit was therefore extended until the completion of tests of a Diesel electric locomotive made by one of our largest builders of steam locomotives.

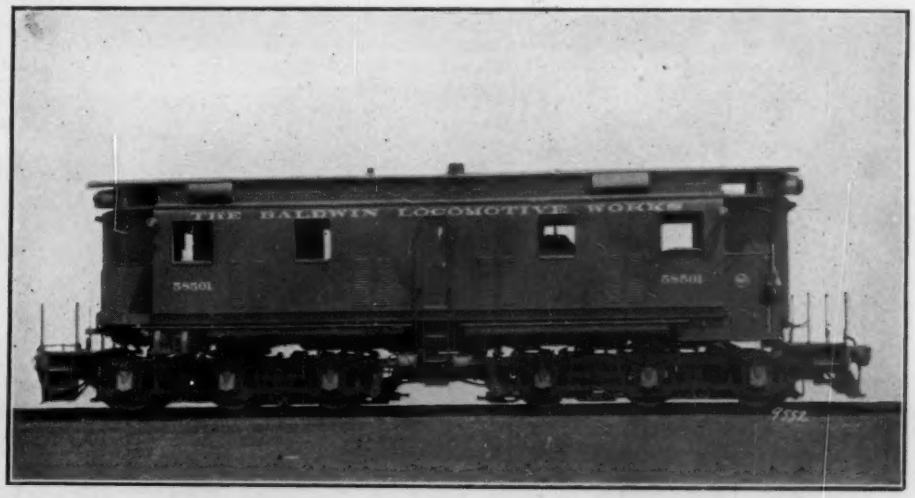
This unit is roughly three times as powerful as the next largest Diesel electric ever built, having a twelve-cylinder engine of one thousand horsepower. This makes it approximately equal in ability to the famous Pershing locomotives. An article, which will appear in an early issue of TECH ENGINEERING NEWS, will explain the many unique features incorporated, such as the use of two crankshafts, and elimination of valve gear on the Diesel engine.

The excellent results obtained in tests have created tremendous interest in the railroad and financial worlds, because these have proved the possibility of eliminating any necessity for expensive, non-paying electrifications of certain sections of railroads.

A Front Wheel Drive Ford at the Institute has occasioned much comment because of the ingenuity of its design and construction and of the desirability of front wheel drive on a car. May we call to your attention the statement in the September 26 *Saturday Evening Post* by Barney Oldfield, that he was "always convinced that the front drive was the logical racing design. . . ." Also, the thrills of the 1925 Indianapolis 500-mile classic were furnished by Lewis bringing in second a front drive racer. The front drive so proved its superior handling qualities and ability that the 1926 classic will probably see several of them — perhaps more than of the conventional type.

Silent Chain Drive from Stock. For a number of years the application of silent chain drives has been an engineering problem requiring individual solution for each installation. One of the large concerns producing this type of drive has recently simplified the problem by offering standardized drives from stock. The results of years of specialized study are immediately available through the use of a simple table, in drives from one-quarter up to ten horsepower and in reductions of one to one to seven to one.—*Industry Illustrated.*

Harnessing the Tides has always attracted schemers, but the people of Maine have signified their willingness to allow anyone with the necessary $100,000,000 or more of resources to carry out such a scheme with the tides of the famous Bay of Fundy. There is known no other place in the world with such a favorable combination of high tides and land configuration. The plan of Dexter P. Cooper gains the most attention. It calls for use of Passamaquoddy Bay, containing 100 square miles of water, as an upper pool, and Cobscook Bay, 50 square miles, as a lower pool, with a power dam between them and dams with gates shutting them off from the Bay of Fundy. With the rising tide, the upper pool gates would be opened, allowing water to flow in; then closed at ebbing tide, while the lower pool gates would be opened, allowing water to flow from it. Thus a constant difference of level of fifteen to twenty feet would be maintained between the pools, which would be utilized at the power-house separating them. Thus made available, there is calculated to be, at a minimum, 500,000 h. p. throughout the year.



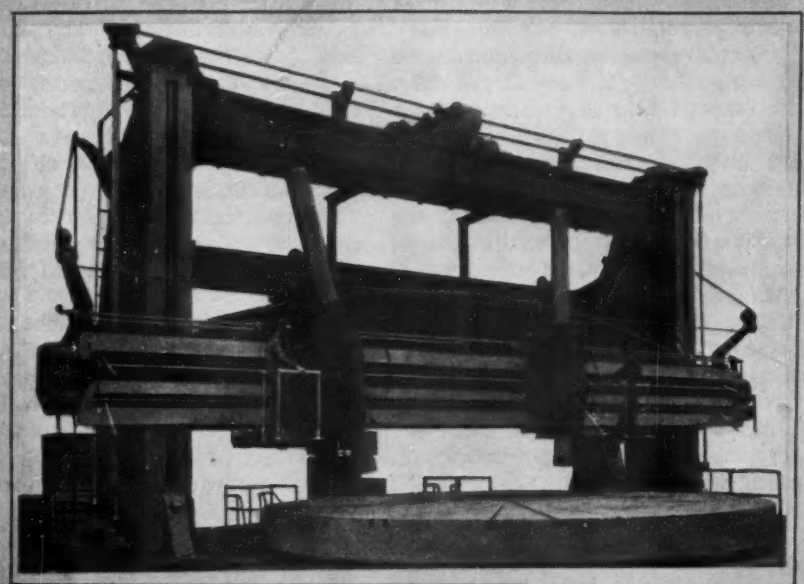
MOST POWERFUL DIESEL ELECTRIC LOCOMOTIVE
This economical unit obviates the necessity for using steam locomotives on sections where electrification would not pay. Starting tractive force, 52,200 pounds.

New Motor Tested. Mr. C. Fayette Taylor, formerly of the designing staff of the Wright Aeronautical Corporation, gave a very interesting talk last May at the annual banquet of the Aeronautical Engineering Society on the problems met in the development of the new 400 h. p. Wright air-cooled motor. Mr. Taylor has since resigned his position with the Wright Company and is now a member of the instructing staff of the Mechanical Engineering Department of M. I. T. as an expert on the subject of airplane motors. Since his talk last spring, the new motor, called the "Cyclone," has been tested in flight.

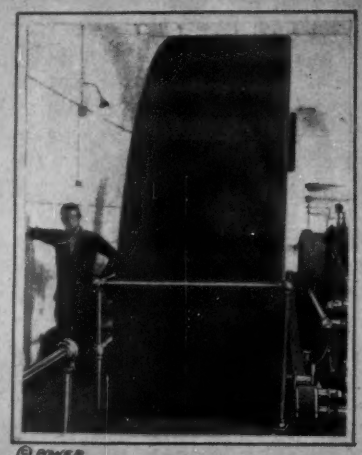
The motor gave the plane a marked increase in efficiency and performance because of the decrease in weight per horsepower of the installation. The Liberty installation, ready for flight, involves a weight of 3.2 lb./h. p., while the Wright "Cyclone" cuts this to 2 lb./h. p., approximately a 40 per cent saving. The advantages of the air-cooled principle for aeronautical work have long been recognized, but the practical difficulties of building units of large size were never before successfully overcome.—*Aviation.*

We Used to Wonder what became of all the old and useless steel rails. We have found out. They are heated and passed through slitter rolls which slit each rail into three sections — then heated to 2,000 degrees and rolled separately into a number of useful forms. Practically all the light farm implement sections were once steel rails. Frames for iron beds, tubing, fence posts, various sizes of angle iron are some of the finished forms. Most important of the rolled products are the I-beams, channels, and other structural steel forms and concrete reinforcing rods which are of such good physical properties that they have practically replaced new billet steel for the same purposes.

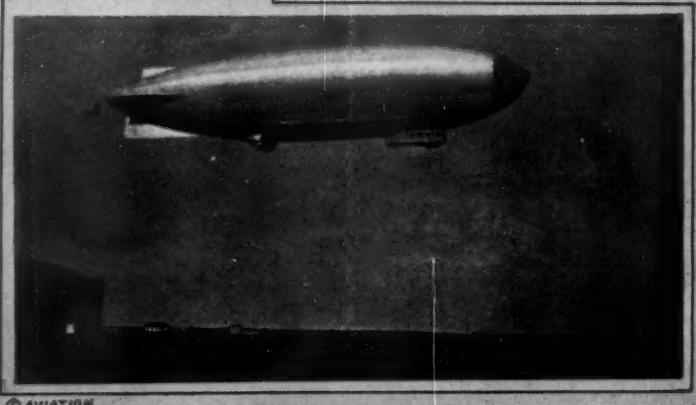
Locomotives now Duco-finished. One of the largest builders of locomotives in the United States has benefited by the use of the famous Duco finish. Formerly, after locomotives were completed and tested, several days were consumed in painting and drying, using an airgun and usual type paints. Using an airgun with Duco, which dries in half an hour, it becomes possible to ship the locomotive the afternoon of the same day painting operations are begun. In addition, the bond between metal and a coat of Duco is very strong; the finish is prettier and more lasting.



A 36 FT. TURNING AND BORING MILL. THE HEIGHT UNDER TOOLS IS 12 FT. DIAMETER OF TABLE - 28 FT.



©POWER
LARGE BELT WHICH AT 5000 FT. PER MIN. TRANSMITS 1000 HORSE POWER. IT IS A 3 PLY BELT, 117 FT. LONG.



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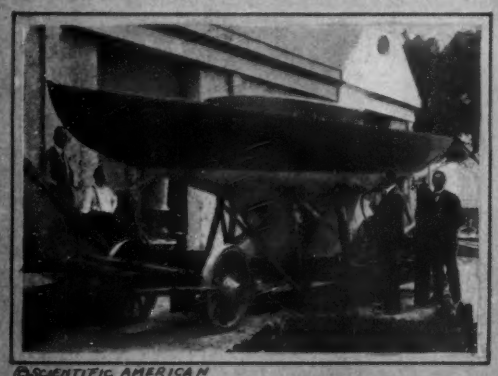
THE ITALIAN AIRSHIP N-2.



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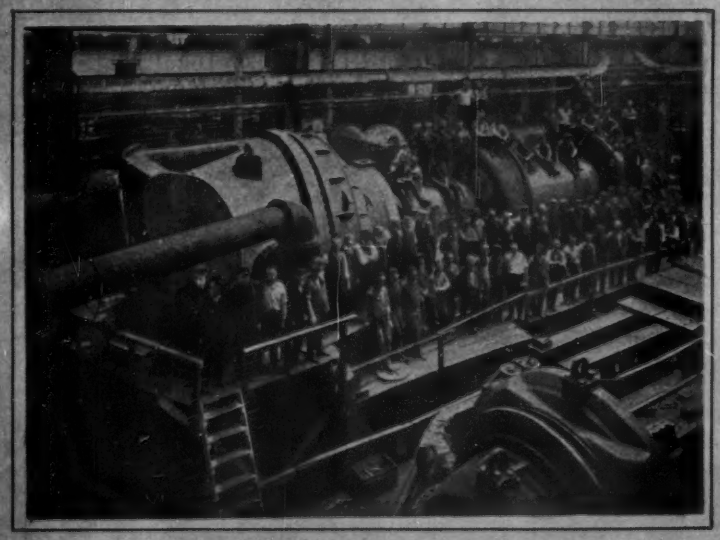
SPRAYING BOATS BOTTOM WITH NEW GUN DESIGNED TO APPLY A SMOOTH, THIN COATING OF MOLTEN METAL TO ANY SURFACE.

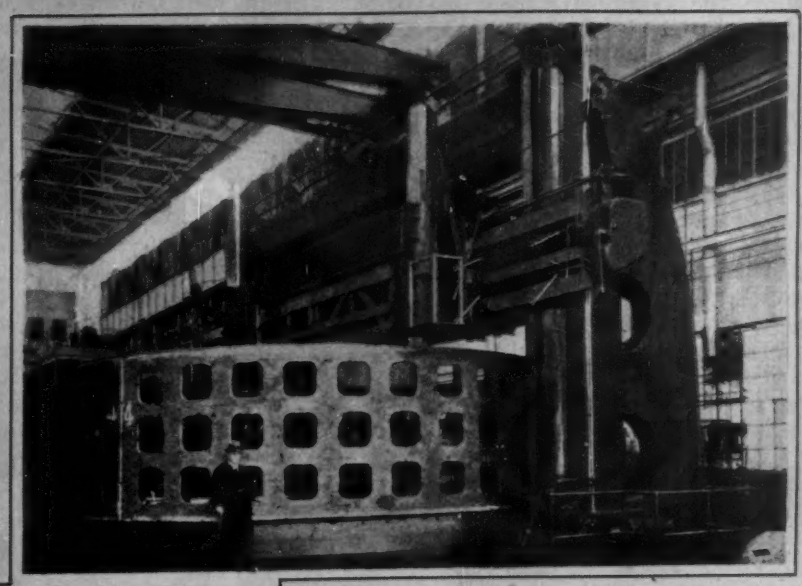
SQUEEZING CABLES, OF THE DELAWARE RIVER BRIDGE, INTO CIRCULAR FORM.



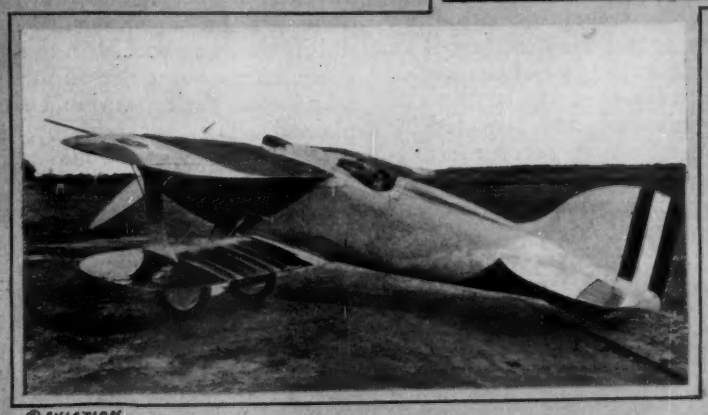
LOW PRESSURE UNIT OF 60,000 K.W. STEAM TURBINE-GENERATOR FOR COMMONWEALTH-EDISON COMPANY OF CHICAGO.

©POWER
FRAGMENT OF EXPLODED TRACTOR BOILER BLOWN 300 FT. FROM SCENE OF EXPLOSION.

© POWER
WHAT WAS LEFT OF THE TRACTOR AFTER THE BOILER EXPLODED.



THE HUGE BORING AND TURNING MACHINE AT WORK. IT WILL CARRY A WEIGHT OF TWENTY FIVE TONS.



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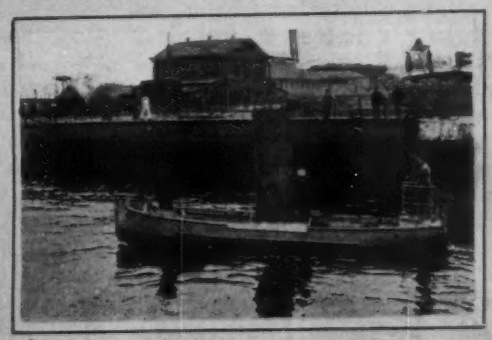
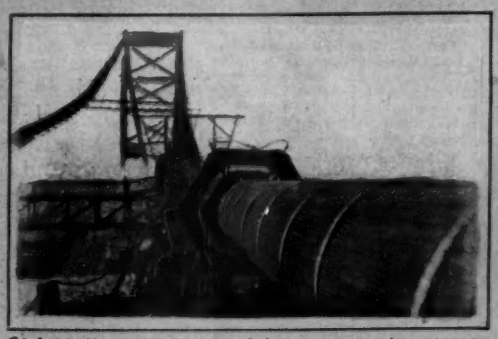
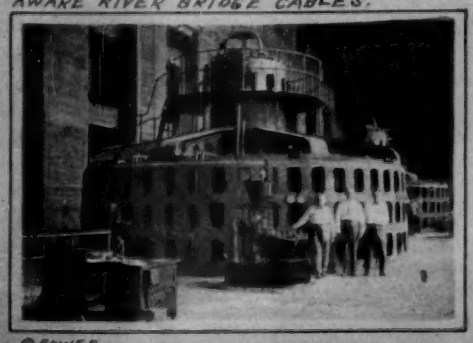
THE 1925 CURTIS RACER.



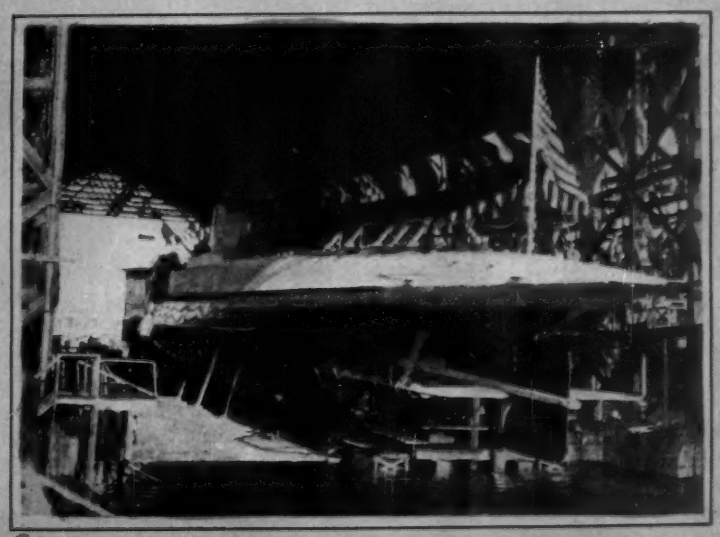
©WIDE WORLD
AMERICAS FIRST ROTOR SHIP, CONSTRUCTED AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY, BEING TESTED ON THE CHARLES RIVER.



CLAMPING THE BANDS ON ONE OF THE DELAWARE RIVER BRIDGE CABLES.



©POWER
STARTING GENERATOR #2 AT MUSCLE SHOALS.



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NEW NAVY SUBMARINE V-2 JUST BEFORE LAUNCHING.

Editorials

WHY PESSIMISM?

Of course the fashionably correct mental attitude to adopt when technical education is discussed is one of deepest gloom or benevolent and slightly amused tolerance. Between these limits, small adjustments of posture bring into view an infinite variety of tempting opportunities for the critic. Systems in general, schools in particular, courses of study, students en masse and individually, afford endless possibilities. Systems and schools are the fortunate recipients of the greatest volume of generously proffered advice. This primarily because they present the immense attraction of descending very seldom to the crushing and painful replies which are apt to be the answer to similar criticism aimed with greater particularity. And meanwhile the schools, having been used to it all for so many years, continue their patient search for the occasional constructive suggestion, while a sense of humor comes to rescue them from exasperation.

Having read a letter or two in the correspondence columns of technical magazines, and listened to some conversation on the subject, one begins to have a vivid idea of conditions in the field of technical training. It appears, in the first place, that the schools are deliberately encouraging great numbers of utterly unsuitable and singularly helpless young men to enroll in their courses. Achieving a considerable success in this attempt, the next process is a systematic and rapid replacement of the few shreds of common sense and initiative in possession of the student by a carefully selected stock of perfectly useless information. To ensure the most effective results, the members of the staff are chosen specifically for their complete failure to make good in the practical application of the branch of knowledge which they are appointed to teach. Finally, the schools having done their part, the finished product is cast upon a hopelessly overstocked market primed with what little he can remember of his acquired information, but with a very definite and carefully fostered knowledge of his complete superiority. In the somewhat unlikely event of one of these strange young men obtaining a technical position, he may be expected to do a number of things. He will, of course, consider his work, whatever it may happen to be, as being far beneath him, and will indeed feel deeply insulted if not called into conference in the first important decision coming up for consideration by the technical and executive heads. If he comes into personal contact with any of the employees, discontent will be certain, and probably serious labor troubles will ensue. Being called upon to perform any small work of design requiring only common sense and elementary knowledge, the result undoubtedly will be such as to move strong men to tears or sardonic laughter, but in spite of this its author will remain obstinately blind to its own imperfections.

Exaggerated? Perhaps! But most of the very points enumerated here have been brought up in letters published within a few months. We should be blind, indeed, if we could not see the obvious imperfections in systems and in schools, and, above all, in ourselves. Cases are quoted by the critics and no one doubts that many occur. There is a germ of truth contained in many of the accusations leveled and it is within our power to reach. Many unsuitable men do try to become engineers, as is the case with every other calling; the jobs we hope for are often hard to obtain, and the graduate is as fallibly human as the rest of the world. And yet railways that are largely designed, administered, and operated by these men continue to carry the citizens of the country in comparative safety. Large numbers of buildings of their design stand and do not fall immediately. Electric power is supplied and communication maintained with no very noticeable increase in the number of enforced stoppages. If there are more qualified applicants for each post, on the other hand, prejudice against the college-trained man is much less general than formerly. As the well-established fields become crowded, others are being opened up. If advancement is slower for the majority, the stability of organizations and the final reward are the greater. This is no attempt to paint the life of an engineer in rainbow colors. A few will achieve riches, and fewer fame, but the best fortune of the great majority of us will be the opportunity to work unremittingly for a living. But we refuse to believe that men who are fully determined to do their best at the vocation of their choice have any more reason to be depressed now by the pessimism of those who delight in discouragement than had their predecessors at any other stage in history.

NATURE'S LAWS

Recent disasters by air and sea must supply much food for thought. In the course of time, much of the truth regarding them may become known. Somewhere a law of nature, perhaps through man's error or perhaps from no fault of his at all, has been violated and the price has been paid. Men speak grandiloquently of conquering and harnessing nature, and all the while man is really learning laboriously the principles by which the animate may control the inanimate with safety and advantage. These principles are the laws of nature and not those which man makes. Success is the reward for their discovery and observance, and would seem to partake more of submission than conquest. Carelessness, or lack of knowledge, or defiance of these laws may not always result in immediate disaster, but sooner or later something occurs to make men ask "Why?"

Where a work of engineering is involved, the errors may be of design, or of organization, or of operation. The men who operate usually are exposed to the dangers in which a violation of principles on their part may involve their charge. Designers or organizers are less likely to suffer this immediate physical result, but if they are the right sort of men, will feel their responsibility the more keenly on this account, while for the same reason men will demand that their position be fully explained. The fact remains, however, that errors of design would seem easier to eliminate than errors of operation, except in so far as the latter can be prevented by mechanical means. It is unlikely that a change in design once found necessary will be omitted in the future. The *Titanic* disaster is perhaps a case in point. Different orders from the company, or more careful handling of the ship, might have led to a complete avoidance of the catastrophe, while different designs might have saved the ship in spite of the accident. For the last ten years almost every passenger ship launched has had embodied in her design the lessons of that occurrence, but it would be a bold man who would assert that ships have never been driven too hard since then.

The truest memorial that can be raised to the memory of those who lost their lives in such disasters is an earnest effort to prevent their repetition, and the application of the lessons so tragically learned to as wide a field of eventualities as possible. So, though it is inevitable that these happenings direct investigation most intensely on the particular line of endeavor involved, the question of other needs also may rise in men's minds.

There never has been any question of giving up the thought of progress because of such happenings. Plans may be modified, but as long as man's nature remains what it is, and until the time comes to call a halt to all this, men will continue to press forward, and if they press forward a little more humbly, and with a renewed respect for the guiding principles, the lesson has not been wholly lost.

The Technical Graduate in Industry

(*Continued from page 97*)

Recent reports before the societies of engineering teachers show that this same viewpoint is beginning to be reflected in the schools themselves. About two years ago a report was presented to the Society for the Promotion of Engineering Education presenting courses based on a functional arrangement of engineering work. One course was designed to prepare men for research and designing, another for manufacturing, and another for the commercial aspects of engineering work. It is right here on this problem that the college has the right to look to industry for help. If the industry cannot make it clear to the college just what the human requirements are, the college has a poor chance to interpret these needs. Just what means are best adapted for establishing understanding between education and industry on this point are not yet fully understood. Some means, however, that some industries have found to be valuable aids in meeting such needs are the sending out of practical men for the purpose of lecturing before students on various phases of engineering work. The colleges themselves, in spite of the crowded curriculum, are well prepared to receive and utilize such a service through the medium of their student branches of the national engineering societies such as the American Institute of Electrical Engineers and the American Society of Mechanical Engineers. Quite a number of industries see fit to afford opportunity during summer months or periods of sabbatical leave for engineering teachers to engage in practical engineering work. Three or more of the larger manufacturing companies actually plan summer conferences for engineering teachers in which, in conjunction with some engineering work, the teacher may acquire in a brief space of time quite a broad contact with many of the principal phases of industry's problems. Other industries are sending out to the schools problems of a practical nature actually drawn from their files, which, if not used in the actual instruction work, are nevertheless valuable in portraying to faculty and students the nature of the work they may be required to meet in practice. Timely messages from industry to the colleges, either in the form of letters or in the form of photographic illustrations, have been found another valuable means of contact. Many of the larger industries operate motion picture and lecture bureaus the subjects of which deal with technical problems, and which are available without cost to the colleges. It must be clearly shown the college men just what the jobs to be done are and what the requirements in each case are. *It is a tremendously bigger problem for the college man to find the right job within the industry he enters than to select the industry.*

Today the young electrical or mechanical engineer may very properly find outlet for his abilities in any of the following fields:

Pure Research	Erection
Design	Application
Manufacturing	Sales

The job specifications for each of the above-named lines of work are very different. Each requires men of different tastes, personalities, interests, and type of mental abilities, but they are all fields for engineers. In general, those lines of work at the head of the list require a higher degree of scholarship, mathematical ability, and analytical prowess with less emphasis on the elements of personality, leadership, cooperativeness, etc.; while the reverse would be true with those functions at the end of the list. Men entering the middle section of the list should be pretty well balanced with physical qualities—physique, health, energy, endurance, etc. The list presents a functional classification of engineering work—a classification, as it were, laid out at right angles to the old-style academic classification referred to above. To go into detail regarding the nature of the duties of engineers in each of these fields would be out of place in a paper of this kind. Most of the larger manufacturing companies have more or less well-prepared job specifications regarding them.

In making a selection of two hundred and fifty college men a year, out of eight to ten times that number of applicants, the Westinghouse Company places more emphasis on choosing groups of men of specific tastes and aptitudes in proportion to the needs of the various functional departments of the organization than on endeavoring to secure all Phi Beta Kappa or Tau Beta Pi men. Scholarship is not the sole criterion. Some college teachers have been greatly surprised at the offers which have been made at the end of a day's work of interviewing. Some men of high record have been rejected, while others of considerably lower scholastic standing have been offered appointments. As near as the system may be reduced to a record form, a scale somewhat similar to that devised by the Committee on the Classification of the Personnel of the Army used for rating officers for promotion is used. A portion of the interview blank is reproduced in small size. Not to go into detail, which can be gotten from a study of the blank, it will be noted that ratings are given in (1) physical qualities, (2) intelligence, (3) leadership, (4) personal qualities, and in (5) special talent. In using the scale, it is essential that the principles laid down by the Army Committee be followed and that each interviewer have established in his mind persons opposite each of the scale. Since the individuals against whom a comparison is made are all recent graduates of the preceding class, and just one step in advance, it is apparent that a candidate is better or poorer than the average now doing the same work as his total is more or less than sixty.

A very careful check is made of the college records, and if personality records are not available, suitable inquiries are made of the teachers to check this point. Ofttimes the opinions of the younger instructors and of classmates are found very valuable in checking the personalities of the men and their standing among their fellows. It is pretty sound reasoning to believe that a student who has stood well in college, has worked well with his associates in laboratory, shop, and test sections, who has shown himself to be free from deceit and selfishness, and, in a word, able to co-operate with others, will display these same qualities when he enters industry.

In every engineering class of size there is some individual who is qualified for each of the several functions of engineering work mentioned above. It is at once the problem of the man and of the industry to see that the square pegs get into the square holes and the round pegs into the round holes. This, of course, cannot be accomplished by a ten or fifteen minute interview, but a start can be made in that direction in that time, and the problem completed within three or four months after entering upon the first job.

In the Westinghouse Company this problem receives a large amount of attention. It is the endeavor to segregate or allocate the new graduate in the industry to some special line within sixty days of his arrival at the plant. It is not always possible to do this, but if the men are systematically acquainted with the work of various departments —designing, research, application, manufacturing, selling, etc.—and are put in touch with the executives in charge of these activities, it is surprising how quickly ninety per cent of the men will come to a decision and how few changes will be necessary later on. One especially valuable means of arriving at this decision is to place the young engineer for a short space of time—say

The Technical Graduate in Industry

(*Continued from page 117*)

from six weeks to two months—in that line of work toward which he feels some inclination, but for which he does not feel ready to make a definite decision. Two months' work in a department—say on the design of railway motors—has invariably been found to be a means of arriving at a definite decision either for or against it as an objective. Suitability for research work can also usually be determined as quickly through the same means. Application and commercial engineering are, perhaps, not quite so susceptible to this treatment. The Westinghouse Company has put its finger on this point as a most critical one in the development of its technical man power. The Company feels that the decision made at this time spells "success" or "failure" for a great majority of its college men. Its leaders are concentrating their thought on the problem of helping the man think his problem through to a decision. Under other conditions he may flounder a half-dozen years and at the end of that time be only ready to make another start under less favorable conditions. It is surprising to note that within groups of two hundred and fifty men a year for the past three or four years, the number who desired to change subsequent to making their decision is exceedingly small.

Descriptions of the types of training courses provided for each of the various groups would be out of place in a brief article of this kind. It should be pointed out, however, that one of the great advantages to the individual in making such a decision early is the fact that it enables him to plan an intelligent schedule of training and transfers for the year which he will put in before passing on into regular engineering work. The usual type of program may be illustrated from the attached schedule of training for commercial engineering in the Company's Railway Sales Department. It will be seen that the time is divided among a variety of shop sections and special class work with special training on the commercial policies and methods of the Company. Throughout the course a portion of the time each week is spent in class work under the guidance of specialists.

The product of the American colleges during the last few years relatively has contained too large a proportion of men who are interested in the technical side of engineering work as compared with the number who are interested in the commercial side. That is, too large a proportion to proportionately satisfy the requirements of industry. It is not meant that there have been too many graduates. In fact, recent findings have indicated that the demand for engineering graduates is far in excess of the supply; but what is meant is that the commercial side of engineering work has not drawn its full share. It has appeared at times as though the engineering schools of the universities were not holding their full share of men of the keen, aggressive, high personality type. While the writer has seen some figures to the contrary from one or two schools recently, it would seem that the engineering colleges have not had more than their share of athletic captains, publication managers, class officers, social leaders, and fraternity men. The writer has been inclined to believe that the country over the schools of Commerce and of Business Administration have been inclined to draw many of this type of American youth from the strictly technical subjects. This is to be regretted, for the general phases of industry, including salesmanship as a large field, are just as big a part of engineering as any other field. To write a job specification for commercial engineering would be a difficult task, and few would probably agree on it after it was written. Ability, knowledge, and personality are all required of those who would succeed in it. Which of these three characteristics is the most important it is impossible to say, but some measure of each is indispensable. The engineering salesman must know his goods, how they are manufactured, their design, the materials, and the workmanship. He must know their uses and applications, and he must know the requirements of their users. In many cases it is his opportunity to act in the capacity of a consulting engineer to the buyer. He must know the people with whom he is dealing, the language of their trade; he must have initiative and imagination. He must find new ways of finding business, of presenting his propositions, and of making friends. He must be persuasive, logical, honest, and faithful. Tact, of course, is an absolute essential. He must be able to play as well as to work. He must have real dignity which expresses itself in his play as well as in his work. It is worthy of comment, perhaps, that while a dearth of material is coming from our technical schools for commercial work, nevertheless, if anything, advancement is probably more rapid in that field than in any other. It is believed that a preponderant proportion of engineering executives has come up through the commercial end of business.

What results does a company such as the Westinghouse get from its program of training technical graduates? Is the expenditure of upwards of $1,000 per man, in addition to what he produces during his year of training, justified? Do the men "stock" to the Company and to engineering? Do they make good? Some facts with reference to the history of the Westinghouse training program may be stated. Then, the reader can draw such conclusions in answer to the questions above listed as seem to him to be justified.

1. The roll of principal executives of the Company, including its vice-presidents, general managers, district managers, district superintendents, departmental managers, works managers, etc., contains a predominant proportion of men who originally entered the Company's employ as students immediately from college.

2. Contrary to the usual opinion of such things, over 50% of the men who come as students remain at the end of a ten-year period. Somewhat paralleling the heavy loss during the freshman year in college, the most of the loss that does occur comes early in this period.

3. The Company has a heavy demand from its larger customers for men trained in the application and operation of its specialized equipment. Over 30% of the men who leave the Company enter the organizations of railway properties, central stations, large manufacturing concerns, etc.

4. Ten per cent of the men were of foreign birth and academic training and returned to their own country to engage in engineering practice.

5. Between 5% and 6% of the trained engineers are returned to the colleges in the capacity of teachers, research assistants, etc.

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Blood

(*Continued from page 99*)

desirable concentrated food products. It thus fulfils the requirements of a food substance, that is, it is rich in energy, readily utilized by the body, wholesome, and practical as an ingredient in prepared foods.

The physical character of the solution of dried blood serum and water is such that it can be "whipped" as white of eggs is whipped to form a white froth of reasonable stability. This froth is less dry than completely beaten egg white, but for all ordinary baking purposes may be substituted for egg white. For comparative purposes cakes have been baked from a given formula, using in the one case egg whites, and in the other redissolved dried blood serum powder. In such actual tests the serum proved to be entirely satisfactory. No odor or taste is imparted by the blood product which enables one to detect it. Delicate formulas calling for egg white, such as those for icings, require special technique in using the dried serum, but the ordinary run of bakery products need no special handling when the powdered serum is substituted for egg white.

Mixed with dried egg yolks, a satisfactory omelet may be prepared without use of whites when serum powder in correct proportions is employed. "Scrambled eggs" may also be prepared in a similar manner. When one considers that dried egg albumin is imported from China each year in quantities amounting to about 3500 tons, it becomes apparent how great may be the use of such a product as has been described. To one who is familiar with the fermentation of eggs which takes place before the Chinese product is dried, and the conditions under which it is prepared, it is obvious that an inspected blood serum does not suffer in wholesome sanitary aspects as compared with Chinese egg albumin; and the comparison must remain favorable even if all imported egg albumin should be prepared under the most sanitary conditions.

The supply of blood seems adequate for present uses and for a certain development of future uses of dried serum albumin.

The dried red product made from the red corpuscles is used in technical and medical fields. There is every prospect that it, too, may be made to serve as a food ingredient for human beings, as it now is used with marked success for higher-grade animal foods, since it contains useful amino acids and iron in organic combination.

A complete statement of the technical uses to which such products might be put in addition to its application as an ingredient of food for man is not possible at the present time. A few possibilities may be indicated. Special foods for animals, such as dog biscuit, chicken foods, fish foods, etc., are obvious. Specialized types of plant foods are certain to be prepared. It is already assured that there will be manifold uses in the preparation of pharmaceuticals, in the manufacture of waterproofings, adhesives, and probably plastics, and in tempera painting. Extension of use in the finishing and dyeing of leather seems most likely.

Where one recalls the great range of materials which modern organic chemistry has developed from coal tar, he is moved to wonder whether modern biochemistry may not similarly develop a great family of technical and food products from this rich source of proteins.

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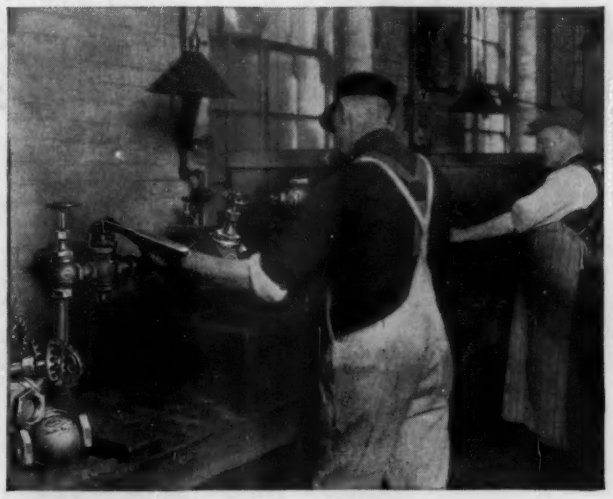

Final test of complete valve

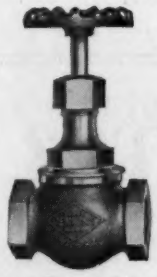

Fig. 106
Screwed, Jenkins Standard Bronze Globe Valve.

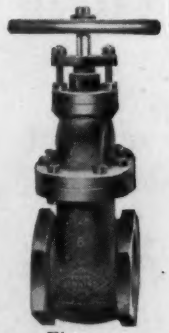

Fig. 325
Screwed, Jenkins Standard Iron Body Gate Valve.

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Water Models for Aeronautical Tests

(*Continued from page 101*)

measurements were made of the changes in form of the contour of the bag at various stations after each change of pressure.

The analysis of the tests showed that when the pressure of the water was such as would correspond to about ¾″ water pressure in the lower part of the bag of the ship (24″ of water in the top of the model), the deflections of the complete model did not much exceed those that were calculated for the actual ship under similar load, assuming complete co-operation between keel and bag. The two materials, the duralumin of the keel and the rubberized fabric of the bag, worked together so as to form practically one compound girder, as do the steel bars and the concrete in reinforced concrete beams. The condition for such co-operation is that the envelope shall be laced tightly and closely to the keel, a condition which will be actually fulfilled in the ship. At low gas pressures the co-operation was not so perfect, but the deflections of the complete model were not much more than one-half of those of the keel alone under a given load. Hence the keel and the envelope in the complete model, under these conditions, share the burden of the load fairly equally.

The breathing tests showed that alterations in pressure caused appreciable deflections of the keel, producing stresses which may form a considerable increment of the total stresses.

By letting some water out of the model bag, conditions were brought about resembling those that are liable to occur when the airship makes a rapid descent. In such cases a partial deflation exists accompanied by slackness in the fabric near the keel amidships, but it was found that this condition did not materially reduce the longitudinal strength of the model below what it is at low pressures.

Based on the results of the model experiments, simple formulas were developed, which permit a calculation of the primary stresses in the keel and the envelope under various conditions of loading.

A few full-scale breathing tests made at Scott Field after the ship was assembled gave results that were in good accordance with the calculations and with the model experiments. No other full-scale tests have been made so far, but it is hoped that there will be an opportunity later to measure the deflections under end loading. Only by a combination of model experiments and full-scale tests is it possible to determine the quantitative values of the physical constants, so valuable in future design.

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Non-Corrosive Steels

(*Continued from page 104*)

For convenience this will be referred to as "Rustless Steel." The addition of this extra 7 per cent of chromium so changes the nature of the steel that it will not respond to hardening. It can be heated and quenched, and the carbides can be dissolved, but the steel does not increase appreciably in hardness, and since there was no electrolytic action before hardening, the non-corrosive properties are in no way improved by dissolving the carbides. Rustless steel is, therefore, always used in the annealed condition.

Because of its higher chromium content, and the addition of copper, rustless steel is more non-corrosive than the stainless cutlery steel, even when the latter is properly hardened and polished. The enormous field of usefulness of rustless steel in the form of bars, forgings, and plates warrants a further description of this type of steel.

Since rustless steel is pearlitic when annealed, it is magnetic and is freely and easily machinable. The steel may be handled in automatic screw machinery without special precautions, and can be held on magnetic chucks for grinding. So far as fabricating the finished article is concerned, this type of steel may be regarded as a rust-proof machinery steel, but it, of course, has obvious advantages over machinery steel, as will be pointed out. The physical properties of rustless steel in the annealed condition are approximately as follows:

Yield Point	68,000 lbs. per sq. in.
Tensile Strength	100,000 lbs. per sq. in.
Elongation in 2"	22%
Reduction of Area	50%
Brinell Hardness	196

These properties are considerably in excess of ordinary machinery steel and can be improved somewhat by different methods of annealing.

Rustless steel is immune to atmospheric or salt water corrosion. It is unaffected by dry or wet steam, carbon dioxide gas, nitric and nitrous acids, gasoline, alkaline solutions, and most neutral or oxidizing reagents with the exception of acid chlorides. It is highly resistant to scaling at incandescent temperatures, and can be commercially used at temperatures ranging up to 2000° F. without excessive deterioration of the surface.

The thermal coefficient of expansion of rustless steel is about .00001 per degree centigrade, which is the same as that for ordinary steel. This is a very desirable feature, as the steel can be used in conjunction with ordinary steel forgings or castings in valves, steam turbines, etc., without the various parts becoming loose, as the temperatures are varied through relatively wide ranges. The difference in coefficient of expansion has constituted a serious objection to the use of certain non-ferrous metals for this type of work.

The specific electrical resistance of rustless steel is 381 ohms per circular mil foot with a thermal coefficient of .41 ohms per degree centigrade. This high thermal coefficient is very useful when the steel is used for electrical heating units. The unit will heat rapidly at low temperatures, but on approaching a red heat, the resistance continually rises, thus decreasing the current and tending to act as a safety-valve to prevent the coils from burning out.

(*Continued on page 126*)

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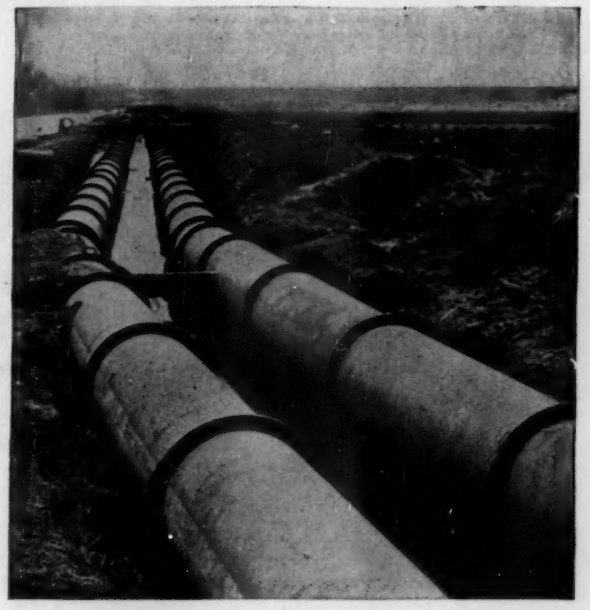

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THIS picture, taken in the salt marshes near Kearny, N. J., shows two lines of 30-inch Cast Iron Pipe replacing pipe made of other material. The alternate exposure to the action of salt water and air is a severe test.

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Non-Corrosive Steels

(*Continued from page 124*)

In conclusion it might be mentioned that many other alloys, such as nickel, silicon, vanadium, molybdenum, titanium, tungsten, etc., have been added to high chromium steels in order to develop special properties for special uses. Copper can be added with beneficial effect to steels containing less chromium than 20.00 per cent, but these products are also at the present time of special rather than general interest. The types described above fairly represent the base compositions which today have the widest commercial appeal.

Steam Railroad Electrification

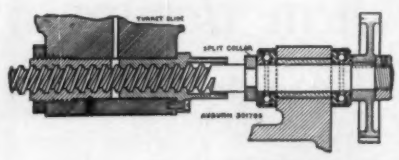
(*Continued from page 108*)

The oil electric locomotive, which has been tried out by a number of railroads in the East, has also aroused considerable interest in railroad circles. This unit uses a six-cylinder engine burning fuel oil, direct connected to an electric generator. The motors are of the standard geared railway type, and advantage is taken of the combination of generator and motor units to control the impressed voltage by regulating the excitation on the generator fields. It is predicted that this type of locomotive will be particularly useful in switching-yards or on general long-haul freight work with infrequent service. In other words, it may be suitable where the capital charge for electrification cannot be justified.

Renewed interest has also been shown in the gas electric car, similar in general design to the large number of units which were placed in branch-line service by many railroads before the War. This new design, which is being used by the Northern Pacific Railway and the Chicago, Great Western Railroad, uses a 175 h. p. gas engine and 110 kw. General Electric generator, motors, and control. The car complete weighs about thirty-five tons, and is particularly suited to handling light branch-line passenger work. It is also equipped to handle some express and baggage such as would ordinarily originate on light traffic divisions. The use of the electric generator and motors in place of the clutch and gear shift required with straight gas engine drive gives a much smoother and more easily operated control. It also permits a more uniform operating speed for the engine, thereby giving improved efficiency and reduced maintenance cost. The operating cost per train mile or per passenger mile shows a very substantial reduction when compared to steam operation.

Two rather important demonstrations of experimental equipment have been carried out by the General Electric Company on their test tracks at Erie, one dealing with heavy current collection and the other a demonstration of the Otheograph. The current collection tests were made to demonstrate the feasibility of collecting from 5000 to 6000 amperes through a single collector at either 1500 or 3000 volts. Prior to these tests, some authorities were of the opinion that 1500 to 2000 amperes was the maximum amount of current which could be collected without injurious sparking at the trolley. The tests at Erie, which were conducted with special equipment, demonstrated practically sparkless collection of between 5000 and 6000 amperes at 60 m. p. h. from a twin trolley contact line by means of one double pan col-

(*Continued on page 128*)



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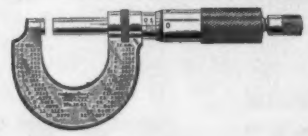

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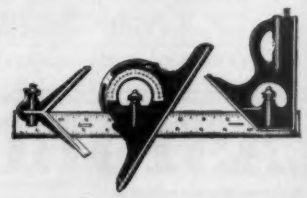

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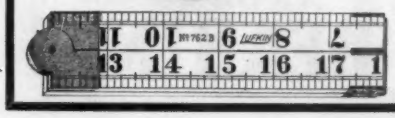

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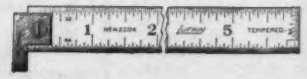

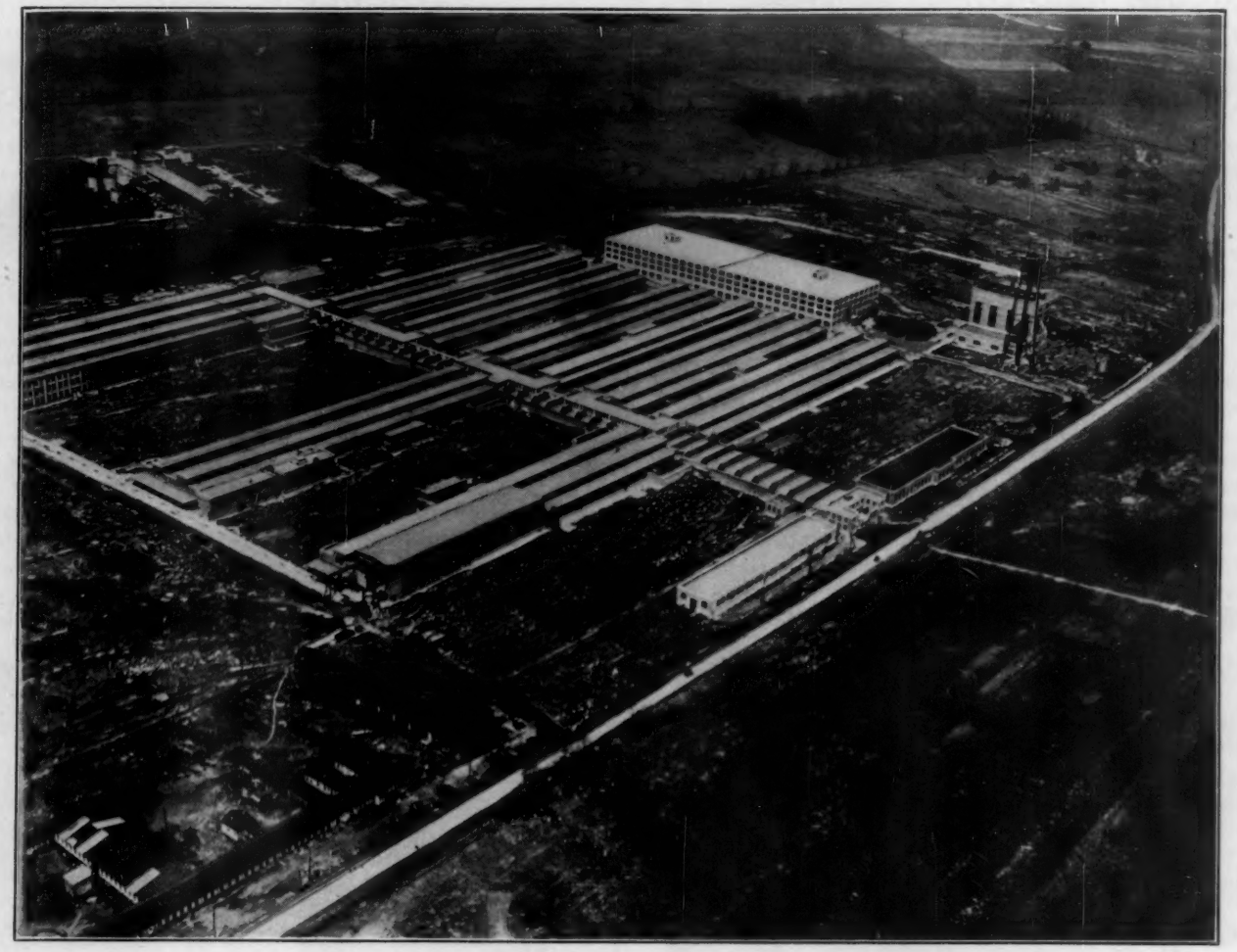

Airplane View of the Plant of the Dunlop Tire and Rubber Corporation, Buffalo, N. Y.
The Foundation Company, General Contractor

THAT "TIME IS MONEY" IS OFTEN TRUE IN BUILDING PROJECTS. THE SPEED REALIZED IN THE CONSTRUCTION OF THE GREAT DUNLOP PLANT STANDS OUT IN THE FIELD OF ENGINEERING ACHIEVEMENT. THE CONTRACT WAS SIGNED IN JANUARY; THE DESIGNS COMPLETED AND GROUND BROKEN IN MARCH; AND TIRES PRODUCED IN AUGUST; ALL IN THE SAME YEAR

ON LAND OR WATER, AT HOME OR ABROAD

THE FOUNDATION COMPANY, AN ORGANIZATION OF DESIGNING AND CONSTRUCTING ENGINEERS, SPECIALIZES IN THE BUILDING OF DIFFICULT STRUCTURES. THE WORK OF THE FOUNDATION COMPANY, THROUGHOUT THE WORLD, INCLUDES ALL PHASES OF PRIVATE OR PUBLIC UNDERTAKINGS IN THE CONSTRUCTION FIELD.

THE FOUNDATION COMPANY

CITY OF NEW YORK

Office Buildings · Industrial Plants · Warehouses · Railroads and Terminals · Foundations
Underpinning · Filtration and Sewage Plants · Hydro-Electric Developments · Power Houses
Highways · River and Harbor Developments · Bridges and Bridge Piers · Mine Shafts and Tunnels

CHICAGO	SAN FRANCISCO	LIMA, PERU	LONDON, ENGLAND
PITTSBURGH	LOS ANGELES	CARTAGENA, COLOMBIA	PARIS, FRANCE
ATLANTA	MONTREAL	MEXICO CITY	LOUVAIN, BELGIUM

BUILDERS OF SUPERSTRUCTURES AS WELL AS SUBSTRUCTURES

Steam Railroads

(*Continued from page 126*)

lector. This amount of power represents considerably more than would be required by any single-unit locomotive.

The Otheograph is a device for recording both the vertical and lateral thrust of locomotive or car wheels when in motion. The tests made included both steam and electric locomotives, as well as loaded freight cars. Steam locomotives were operated at speeds up to seventy miles per hour, and the Paris-Orleans gearless passenger locomotive then in test made records as high as 105 miles per hour. The data obtained are of considerable assistance in checking the impact values of various designs of motive-power equipment.

In all of the 3000-volt electrification projects so far installed, electric locomotives have been used to replace existing steam equipment. The question, therefore, has been raised as to whether it is feasible to use 3000 volts for multiple unit car work. In order to definitely answer this question, a 3000-volt motor car and trailer was equipped and operated as a demonstration over the Erie test tracks. The experiments indicated that it was entirely feasible to use 3000 volts for this kind of service.

Rubber

(*Continued from page 107*)

form, increased amounts of the preservative are required, and for this purpose ammonia seems to be about as satisfactory as any yet tried. The liquid latex is taken by tank cars to the shipping point and pumped, the same as oil, through a hose into storage tanks on steamers, and in that way shipped to this and other countries.

The uses of latex, as such, are increasing rapidly. It is being used in paper, hose, adhesives, for spreading purposes on various articles, etc., etc. Probably the most important use of liquid latex so far developed is in the manufacture and treating of web fabric for cord tires. The results have been remarkable, both from an economy and quality point of view. The uses of this material directly in manufactures are in their infancy, and it is safe to predict that the future will witness large strides forward in its consumption.

World Production and Consumption of Rubber

The United States Department of Commerce and other sources have issued from time to time very complete reports on the crude rubber situation. The world's exports of rubber in the year 1923 were valued at $240,000,000, of which the United States imported seventy-seven per cent. About ninety-five per cent of the rubber used today comes from plantations located in Southeastern Asia and near-by islands. In all, it is estimated that over 4,000,000 acres are planted under the control of Great Britain, Holland, and France. Of these, nearly seventy per cent are controlled by Great Britain.

The consumption of rubber in the United States has had a tremendous growth since 1870. From that date until 1911, before the automobile became an important factor, it is reasonable to assume that the growth was due to the increasing use of rubber goods by an increasing population. Rubber raincoats, boots, shoes, erasers, hot-water bottles, etc., had definitely grown to a permanent place in the standard of living. Statistics show that the imports of rubber by the United States in 1870 were about 4000 long tons, which increased normally to 1911 to about 32,000 tons. From this point to date the imports of crude rubber have increased very rapidly, until for the year 1925 it has been estimated that United States consumption will approximate 375,000 tons and world

(*Continued on page 130*)

Electrical Equipment

LESS THAN WHOLESALE

Ψ

We have a large stock of all kinds of Radio and Electrical Equipment which we are able to offer to M. I. T. men at *real low prices. This equipment is suitable for:*

Radio Work
X-Ray
Electroplating and Electrolysis
Arc Furnace
Thesis and Experimental Work

Ψ

RADIO SURPLUS CORP.
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Founded 1878 — OKONITE — Incorporated 1884
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The Standard for Rubber Insulation

OKONITE PRODUCTS

are available for all electrical purposes.

They have stood the test of time and are recommended by prominent Electrical Engineers everywhere.

- Power Cables (Okonite and Varnished Cambric)
- Submarine Cables
- Parkway Wires & Cables
- Signal Wires
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- Telephone & Telegraph Wires
- Okocord (hard service cords)
- Portable Cords
- Ignition Wires
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- Okoloom (Hard Finish for Hard Service)

Write for handbook
"INSULATED WIRE & CABLE"

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SHOP LIGHTING.

In an address delivered before the members of the Western Pennsylvania Division of the National Safety Council, Pittsburg, Pa., March, 1918, by C. W. Price, the importance of good lighting in industrial establishments was discussed, and the disadvantages of poor lighting were clearly shown by some figures mentioned by Mr. Price.

A large insurance company analyzed 91,000 accident reports, for the purpose of discovering the causes of these mishaps. It was found that 10% was directly traceable to inadequate lighting and in 13.8% the same cause was a contributory factor. The British Government in a report of the investigation of causes of accidents determined a close parallel to the findings of the insurance company above quoted. The British investigators found that by comparing the four winter months with the four summer months, there were 39.5% more men injured by stumbling and falling in winter than in summer.

Mr. John Calder, a pioneer in safety work, made an investigation of accident statistics covering 80,000 industrial plants. His analysis covered 700 accidental deaths, and of these 45% more occurred during the four winter months than during the four summer months.

Mr. C. L. Eschleman, in a paper published in the proceedings of the American Institute of Electrical Engineers several years ago, reported the result of an investigation of a large number of plants in which efficient lighting had been installed. He found that in such plants as steel mills, where the work is of a coarse nature, efficient lighting increased the total output 2%; in plants, such as textile mills and shoe factories, the output was increased 10%.

In an investigation of the causes of eye fatigue, made by the Industrial Commission of Wisconsin, it was found that in a large percentage of industries, such as shoe, clothing and textile factories, the lack of proper lighting (both natural and artificial) resulted in eye fatigue and loss of efficiency. At one knitting mill, where a girl was doing close work under improper lighting conditions, her efficiency dropped 50% every day during the hours from 2:30 to 5:30 P. M.

The above mentioned incidents indicate how important a factor lighting is in the operation of the industrial plant. It has been well said, "Light is a tool, which increases the efficiency of every tool in the plant." Glare or too much light is as harmful as not enough lighting, and in no case should the eyes of the workers be exposed to direct rays, either of sun or electric light.

Windows and reflectors should always be kept clean; that is, cleaning them at least once a week, for where dust and dirt are allowed to collect, efficiency of the light is decreased as much as 25%.

Good lighting, in addition to its other marked advantages, is a strong incentive towards keeping working places clean, for it clearly exposes any place where dirt or other material has been allowed to collect. White walls and clean windows glazed with Factrolite Glass will eliminate the sun glare and increase the illumination 25 to 50 feet from the window from 38% to 72% as compared with plain glass.

Lighting is of primary importance to every employer and fully warrants a careful investigation of the subject, for there is no substitute for good lighting, and if it is not supplied the efficiency of the entire working force must suffer a serious reduction.

If you are interested in the distribution of light through Factrolite, we will send you a copy of Laboratory Report—"Factrolited."

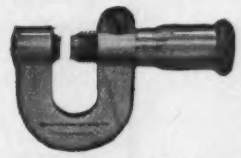
MISSISSIPPI WIRE GLASS CO.,

220 Fifth Avenue,

St. Louis. New York. Chicago.

From "Sheet Metal Gauge" to the "World's Handiest Machinists' Tool"

WHEN Messrs. J. R. Brown & Sharpe, introduced the "Pocket Sheet Metal Gauge" in 1867, they did not realize that this tool, although it served its purpose well, would develop into the finished, dependably accurate and widely used Brown & Sharpe Micrometer Caliper of to-day. Since then over 400 styles and sizes of Micrometers have been developed by Brown & Sharpe for different industrial needs, all of them embodying the measuring principle of the original gauge.



Pocket Sheet Metal Gauge of 1867

In the production of the Micrometers and the rest of the 2000 fine Machinists' Tools included in the line, the Brown & Sharpe Mfg. Co. maintains with pride, a traditional accuracy and standard of excellence.

That is why Brown&Sharpe Tools are preferred and used by the best men in the mechanical profession the world over.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R.I., U.S.A.

Rubber

(*Continued from page 128*)

consumption will exceed 500,000 tons. In 1917 the estimated stock of rubber on hand in the world was about 160,000 long tons. In 1921 this had grown to over 300,000 long tons. With production slightly below 500,000 tons in 1925, it has been estimated that the world's stocks at the end of the year will approximate 130,000 tons against an estimated consumption as previously mentioned of over 500,000 tons.

The Stevenson Act, about which more will be said later, is considered to be largely responsible for the reduction of stocks on hand and the increase in price. The average price of rubber for the year 1917 was slightly over 70 cents per pound. This declined in 1921 to an average for the year of slightly over 16 cents. In June of this year the price had advanced to over $1.00 per pound. It can thus be seen that the economic forces of supply and demand are functioning just as truly in the case of rubber as along other lines. The production of rubber in 1917 was approximately 275,000 tons. This had increased in 1919 to nearly 400,000 tons, when a sharp decrease was noted to about 300,000 tons in 1921. Estimates of production indicate for the year 1925 that 475,000 tons will be reached, or considerably below the consumption expected. Forecasts indicate that even if business in this country keeps on for another year as it has this year, and high prices of rubber are maintained, the production of rubber will exceed consumption slightly during 1926, due largely to the automatic release of restriction caused by the Stevenson Act.

Stevenson Act

Until the year 1920 the price of rubber was sufficiently high to yield profits which would warrant the investment of capital in new plantations. From 1906 to 1920 250,000 acres on the average were planted each year. Since it takes about six years for a rubber plantation to come into bearing, the industry as a whole apparently did not realize that the plantation area was becoming so large that production would exceed demand. For ten years previous to the War, that is, 1904 to 1914, the average London yearly price of rubber was about $1.35. At no time did it fall below 75 cents. During the War it averaged 60 cents and did not drop much below 50 cents. For five years after the War the average price was about 32 cents. For the years 1919 and 1920 it was close to 50 cents, but in December of the latter year went as low as 16 cents. This price so alarmed the plantation owners that the Council of the Rubber Growers' Association in London considered possible remedies to meet the situation. Production was increasing in spite of the decline in output of wild rubber.

The result of the deliberation of the Association was a plan calling for the voluntary restriction of output. About 90% of the members agreed to the proposal, but among the non-member growers the policy was not welcomed. This was true particularly of the Chinese and other plantation owners who operated at very low cost. Since the Association controlled only one-third of the total British Plantation area, it was felt that the policy of non-co-operation on the part of the non-members would destroy any restrictive plan.

The discouraging situation continued, however, and became even more critical in 1921, at which time the average price of rubber for the year reached about 16 cents, the lowest price being 11½ cents in July. It was then proposed that a controlling company be organized for the purpose of exerting effective control over output. This did not receive the support of the British Colonial Office, which became interested in October, 1921, to the extent of appointing a committee to study the situation and suggest remedies. At the end of 1921 the committee was ready to make its report, and, while impressed with the gravity of the situation, it refused to favor the adoption of restriction measures by the Government unless it was with the support and co-operation of the Dutch Government. The report was issued

(*Continued on page 132*)

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and

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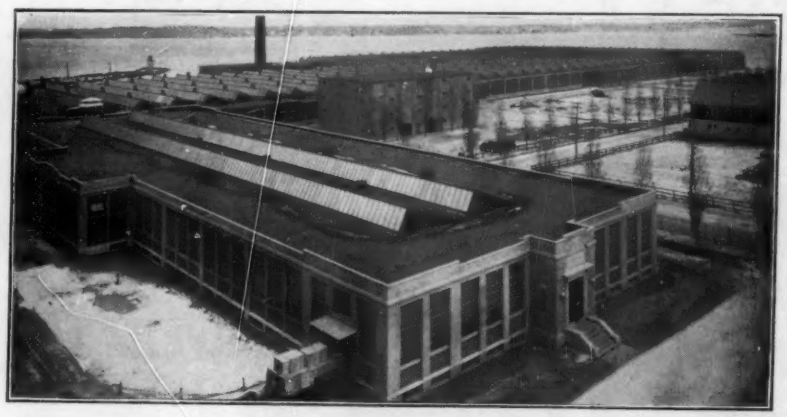


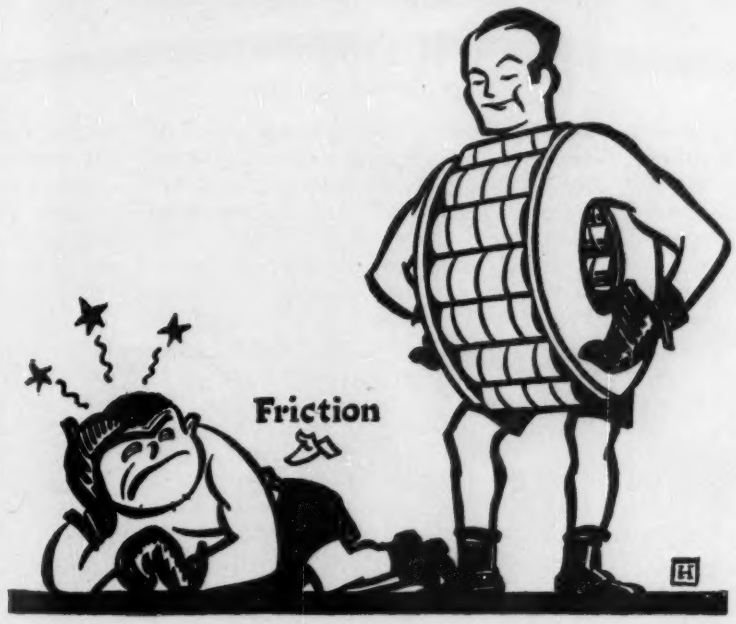
One of the finest textile mills in the world, built by Wm. T. Reed Co. Several repeat orders have been received from this firm

WILLIAM T. REED CO.

Building Construction

200 DEVONSHIRE STREET, BOSTON

We are organized and equipped for the efficient handling of mercantile and industrial building construction of all descriptions.



A knockout blow

for that thief of energy—friction

MOST of us have blistered our hands with wielding shovels or tennis rackets. Early in life we learn the destructive power of friction.

And in the industrial world this thief of energy has been a big factor to contend with. But wherever it encounters a Hyatt roller bearing it gets a knock-out blow.

For where Hyatt bearings are used there is rolling motion instead of rubbing friction. Wheels, shafts, gears and pulleys turn easily. Power is saved, lubrication needs reduced and useful life of equipment lengthened.

You engineers will soon become a part of the world's industrial life. You will be designing, specifying and installing all manner of mechanical equipment. When that time comes, just remember the part that Hyatt bearings are playing and the service they are prepared to render you.

HYATT ROLLER BEARING COMPANY
NEWARK, NEW JERSEY

HYATT
Roller Bearings

WOULD you like to have a small nickel plated Hyatt bearing for a paper weight? If so, let us hear from you mentioning the name of your school.

Rubber

(*Continued from page 130*)

early in 1922, and as a result a new decline started in the price of rubber. When the Dutch Government officially stated its unfavorable attitude toward a restriction plan, the price dropped to about 13½ cents per pound.

In the face of encouraging signs, particularly in the automobile and tire industries at this time, the special rubber committee of the British Colonial Office nevertheless presented a supplementary report on October 2, 1922, in which they reversed their previous judgment and strongly urged an immediate scheme of Government intervention and control in Ceylon and British Malaya.

The act resulting from these findings, known as the Stevenson Restriction Act, provided for a standard production for each rubber estate based on the actual output of that estate for the year ending October 31, 1920, plus an allowance for production from new areas. A certain percentage of the total standard production was allocated for exportation at a minimum duty in each quarter depending on the average price of rubber during the preceding quarter. For the first quarter, beginning November 1, 1922, exportation was set at 60% of the total standard figure. An average price of 1s 3d to 1s 6d during a stated quarter would bring about an additional release of 5%, or 65% of the standard production. An average price of 1s 6d to 1s 9d would result in a 10% release. If the price should average less than 1s per pound during a three-months period, a reduction in the release by 5% was provided for the following quarter.

Restriction is still in force. There have been, however, two unforeseen happenings which have lessened its effect somewhat. The adoption of restricted measures advertised to the world that there was at that time a potential over-supply of rubber. Consequently manufacturers did not feel the necessity of carrying such large stocks. High prices, moreover, stimulated the production of rubber under the Dutch Flag. This has precipitated another international controversy, the British planters claiming the Dutch are reaping the benefit of their restriction measures without carrying any of the burdens. So far, the Colonial Office in Holland has resisted firmly all efforts of the British toward the adoption of restrictive measures in the Dutch East Indies.

On May 1, 1925, the price of crude rubber having been 1s 6d or above for the previous three months, restriction was automatically released 10%, which brought the production for the quarter beginning May 1st up to 65% of standard. On August 1st, due to the maintenance of the price, a further 10% was released, bringing the production to 75% of standard. If the price remains above 1s 6d for the nine months following August 1st, restriction will be automatically released May 1, 1926.

Reclaiming of Rubber

The reclaiming of rubber plays an important part in the industry. The process of reclaiming rubber may be divided into two parts, known as the acid process and alkali process. The acid process is gradually being replaced by the alkali process, so the former will not be described here. The chief problem in the process is to segregate the rubber from the cotton, with which it has been combined in manufacture.

In the alkali process of reclaiming rubber, the material to be reclaimed, such as tires, passes through crackers or grinders and is reduced to a fine pulverized condition. This material then passes over screens where the larger particles are taken out and con-

(*Continued on page 134*)

TECHNOLOGY BRANCH

76 Massachusetts Ave., Cambridge, Mass.

This is the place to which all Technology men instinctively turn when seeking technical and scientific books

We have an arrangement with the two leading publishers of books along these lines to send us copies of all the new books they issue immediately upon publication. The publishers we refer to are John Wiley and Sons Co. and McGraw-Hill Book Co.

Our shelves are always open for your inspection and you are welcome to look them over.

Technology Branch

HARVARD CO-OPERATIVE SOCIETY

New Union Station, Chicago, and Koehring

THE new terminal of the Chicago, Milwaukee and St. Paul, Chicago, Burlington and Quincy, Chicago and Alton and Pennsylvania railroads now being completed, will be the finest railway station in the world. Covering two entire blocks, the value of the buildings alone is $15,000,000.

Caisson work, retaining walls, substructures; concrete arches, superstructure—the concrete work throughout on this Union Station is another product of Koehring Concrete Mixers.

Over 22,000 cubic yards of concrete were used in the 163 caissons, retaining walls and substructures; and approximately 25,000 cubic yards additional were required for the arches and superstructural work.

Koehring Mixers and Pavers are identified with the noteworthy building and road construction projects in all parts of the country.

"Concrete—Its Manufacture and Use", now in its fourth edition, is a 207 page treatise on the uses of concrete, including 26 pages of tables of quantities of materials required in concrete paving work. To engineering students, faculty members and others interested we shall gladly send a copy on request.

KOEHRING COMPANY
MILWAUKEE WISCONSIN

Manufacturers of Pavers, Mixers—Gasoline Cranes, Draglines, Shovels

Rubber

(*Continued from page 132*)

veyed back to the crackers for further grinding. The fine material passes over magnetic screens where the particles of iron are taken out. It then goes to bins where it is fed automatically into huge spherical kettles known as digesters. There, it is mixed with an alkali or caustic, subjected to rotation and heat for a number of hours, when it is discharged into wash bins that wash out the alkali solution. The material left is free from fabric or cotton, and goes to bins where it is allowed to settle. From there it is conveyed to driers which reduce the moisture content to a very small percentage. The material is then ready for the milling, sheeting, and refining operations, where various compounds may be added to obtain the type of reclaimed rubber desired. One of the last operations is to pass the reclaimed material through tubers which force it through a fine meshed screen, taking out any particles of brass or iron that may be left.

There are various kinds of reclaimed rubber known both by numbers and names. With rubber at present prices of about 85 cents per pound, reclaimed rubber is of great importance to the industry.

Conclusion

It is only about sixty years since we have known how to use rubber, yet it would set us back more than a century in the comfort of business and living if it should stop. As the use of animal skins paved the world with leather, so the invention of pneumatic tires, and rubber soles and heels, has cushioned the world with rubber. The rubber industry is still in its infancy.

Movies by Radio are now an accomplished fact. C. F. Jenkins, whose system for radio and telegraphic transmission of pictures, as explained by him in the TECH ENGINEERING NEWS for October, 1924, has been most successful, has succeeded in taking the next logical step. He has sent moving pictures for a distance of five miles by radio. His system will send the pictures in full color and throw them directly on a screen. This will make broadcast entertainers visible as well as audible to their radio audience.

Recent Books

(*Continued from page 109*)

There is one chapter on microscopes for special purposes.

"L'isotopie et les éléments isotopes." By Mme. Pierre Curie. Paris: Société Journal de Physique, 1924. 210 pp.

Mrs. Curie develops in this book a concise, accurate survey of the modern theory of isotopes. Although written chiefly from the standpoint of the chemist interested in the study of the radioactive elements, sufficient general discussion of the problem is brought in to make her treatment of interest to the physicist. The volume is divided into four parts, of which the first is devoted to the radioactive elements and comprises chapters on such topics as the periodic classification of the elements, radioactive transformations, the chemistry and electrochemistry of the radioactive elements and their classification. The second part is given in its entirety to positive rays and the methods for their analysis, and includes the presentation of the elementary pre-relativistic theory of deviation by an electric and a magnetic field leading up to Thomson's method of mass analysis. Two masterly chapters are devoted to the analysis of the results of Aston's mass spectrograms, and an up-to-date table gives the results of mass analysis by various investigators in this field. The third part is a brief — and necessarily none too complete — survey of the Rutherford-Bohr theory of atomic structure, again mainly from the standpoint of the chemist interested in nuclear physics. The last part is devoted to the methods of separation of isotopes, including gravitation, centrifuging, thermal diffusion, mobility of electrolytic ions, chemical affinity, fractional distillation, diffusion, effusion, and the velocity of chemical reaction.

The book is thoroughly in keeping with the high reputation of the writer and will undoubtedly prove of interest to the physicist, and especially to the chemist. A fairly impartial and complete bibliography on the subject-matter is appended.

M. S. VALLARTA.

STANDARD INSTRUMENTS OF PRECISION

C. L. Berger & Sons, Inc.
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SAMSON SPOT SASH CORD

Trade-Mark Registered U. S. Patent Office
Made of extra quality cotton yarn, carefully inspected and guaranteed free from all imperfections of braid or finish. The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds, and colors, for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.
CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST
SAMSON CORDAGE WORKS -:- 88 Broad Street, Boston 9, Mass.

The question is sometimes asked: Where do young men get when they enter a large industrial organization? Have they opportunity to exercise creative talents? Or are they forced into narrow grooves?

This series of advertisements throws light on these questions. Each advertisement takes up the record of a college man who came with the Westinghouse Company within the past ten years, immediately after graduation from his university.

This Graduating Thesis Bore Fruit

G. E. LUKE

BACK in 1917, G. E. LUKE, a Princeton student, wrote a thesis on heat flow in electrical apparatus. The world was not fired upon receipt of this opus; it went on, in fact, very much as it had gone before. But LUKE came to Westinghouse, where his interest was encouraged. Today, although less than ten years off the steps of Old Nassau, he has completed researches that have improved the motor- and generator-building arts.

An interesting problem that came to him here was the development of an analytical or mathematical method of predetermining the temperature of a motor or a generator under a given power cycle. Nothing so comprehensive had been undertaken before. When developed, however, the method would permit a more scientific application of motors and generators to practical requirements. Safety factors could be cut down. Smaller apparatus could be used, with resulting economies.

The work was exacting and the researches not spectacular. In the end, however, there emerged a formula that is now the property of the industry and that stands as an important addition to the field of engineering information.

This incident shows the opportunities which the electrical industry affords the research engineer of genuine endowments. Today this young man has charge of the insulation section of the research department, with an organization of three physicists and five assistant physicists.

His work calls for the broadest kind of experience, for it relates to every kind of electrical apparatus in which heat flow occurs. Half the problems of his section are referred to it by other departments of the Westinghouse business—they are in the nature of emergency calls. The other half are of the department's own initiating. From these come many of the most revolutionary developments in the electrical art.

Westinghouse

W WESTINGHOUSE ELECTRIC

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASS.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY offers courses, each of four years' duration, in Civil, Mechanical, and Electrical Engineering; Naval Architecture and Marine Engineering; Mining Engineering and Metallurgy, and Geology; Architecture and Architectural Engineering; Chemistry, Chemical Engineering, and Electrochemical Engineering; Biology and Public Health, and Sanitary and Municipal Engineering; Physics, General Science, and General Engineering; and in Engineering Administration. These courses lead to the Degree of Bachelor of Science.

To be admitted to the first-year class, applicants must have attained the age of seventeen years, and must satisfactorily fulfil entrance requirements in Algebra, Plane and Solid Geometry, Trigonometry, Physics, Chemistry, English, History, and French or German, and one elective subject. Examinations are required in all subjects except Chemistry, History, and the elective, the requirements for which are fulfilled by the presentation of satisfactory certificates. A division of these entrance subjects between different examination periods is permitted.

Entrance examinations are held at the Institute in September. In June, applicants will be examined by the College Entrance Examination Board in Boston, New York, Philadelphia, Chicago, and many other cities in America and Europe. A circular stating times and places is issued in advance by the College Board.

Graduates of colleges and scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding to at least one year's work at the Institute, are admitted, without examination, to such advanced standing as is warranted by their previous training.

Graduate courses leading to the degrees of Master of Science, Master in Architecture, Doctor of Philosophy, and Doctor of Science are also offered. Special Research Laboratories of Physical Chemistry, Applied Chemistry, and Science have been established.

PUBLICATIONS

Bulletins of General Information, Courses of Study, Summer Session, Advanced Study and Research; and the Report of the President and the Treasurer.

Any of the above-named publications will be mailed free on application.

For information, address

ADMISSIONS OFFICE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE 39, MASS.

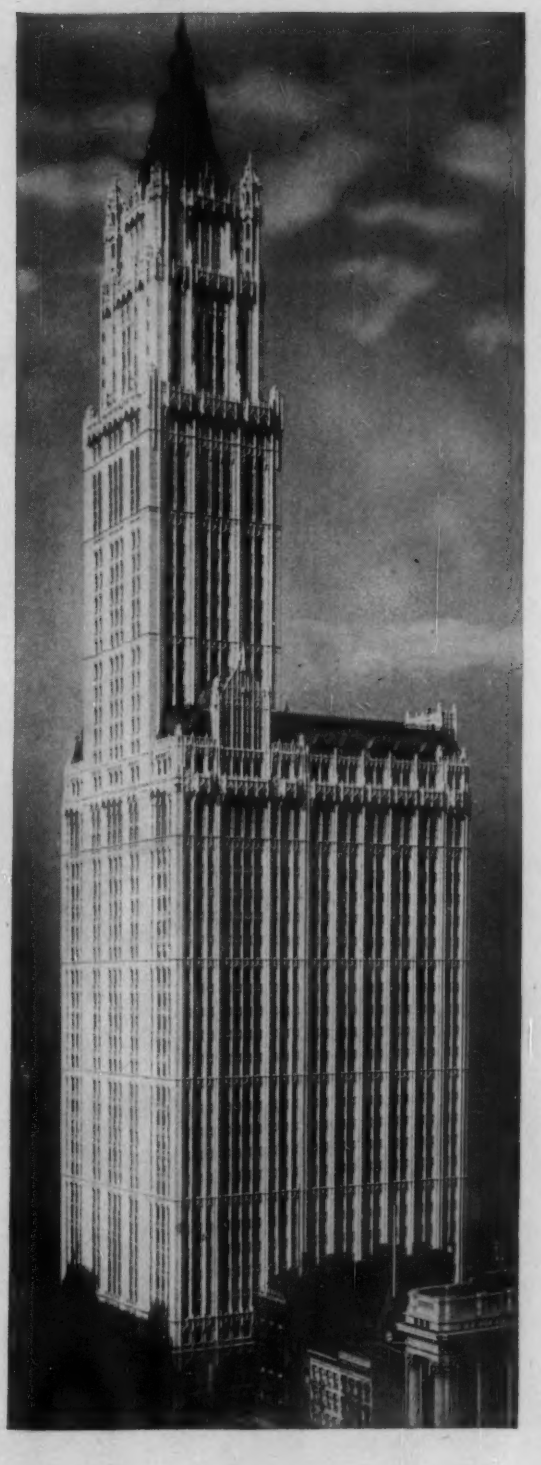
He Believed a Lie and Scorned the Truth

A YOUNG PEASANT of Central Europe was eagerly questioning two Harvard men regarding the wonders of New York.

The first one told him that some of the New York buildings are so tall that they are snowcapped all the year. The peasant stared a moment at this, but decided it must be true

Then the second Harvard man spoke of the great buildings equipped with dozens of elevators, some for local service, some for express to the twentieth and higher storeys. The peasant burst out laughing and said, "Now you are making fun of me!"

Strange but true, of the two marvels the real one was harder to believe. The identification of Otis Elevators with the buildings of New York and other great cities of the world is accepted quite casually by those who visit the important world centers.



THE WOOLWORTH BUILDING, *New York is the highest commercial building in the world. The Otis tower elevators travel a distance of 680 feet, running at a speed of 600 F. P. M., there being 26 Otis elevators in the building.*

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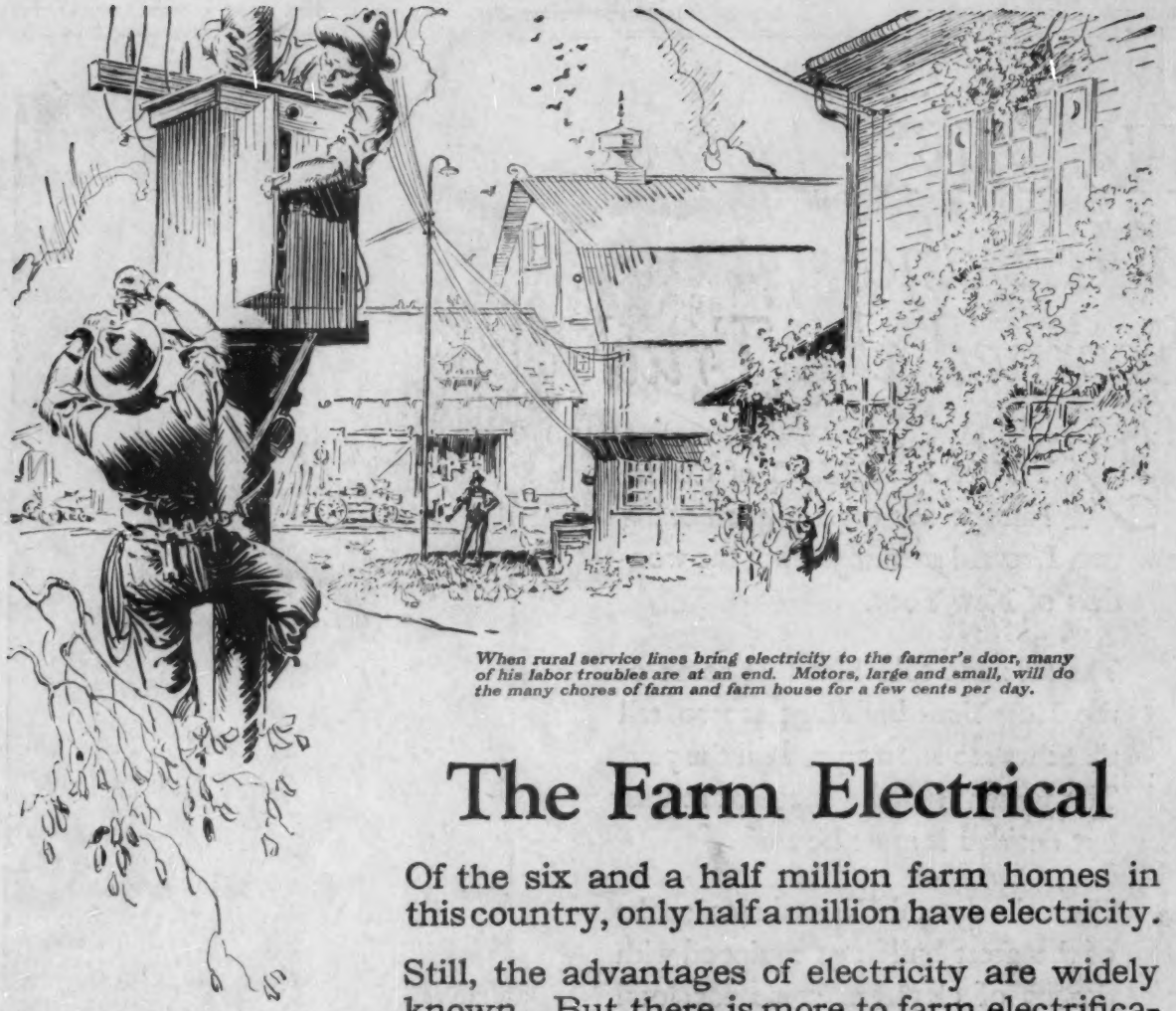
Offices in all Principal Cities of the World



When rural service lines bring electricity to the farmer's door, many of his labor troubles are at an end. Motors, large and small, will do the many chores of farm and farm house for a few cents per day.

The Farm Electrical

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Six million farms to be electrified! Here is a vast and virgin field for the application of electricity, with countless opportunities for college-trained men in the technical and commercial phases of this undertaking. And for the agricultural college student and others planning a future life in rural sections, it means a better, bigger, happier life-time now in the making.

Since its inception the General Electric Company has pioneered in the various fields of applied electricity. Today G-E engineers are co-operating with various State agricultural committees in the study of farm and rural electrification. These committees include members of the agricultural college faculties.

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